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Cy No. 33

EARTH RESOURCES TECHNOLOGY SATELLITE
FINAL REPORT

9. CONFIGURATION MANAGEMENT PLAN

PREPARED FOR

GODDARD SPACE FLIGHT CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

UNDER CONTRACT NAS5-11260

TRW SYSTEMS GROUP

IBM FEDERAL SYSTEMS DIVISION

Itek OPTICAL SYSTEMS DIVISION

EARTH RESOURCES TECHNOLOGY SATELLITE

FINAL REPORT

Volume 9. Configuration Management Plan

April 17, 1970

prepared for

National Aeronautics and Space Administration
Goddard Space Flight Center

Contract NAS5-11260

item 5a

TRW Systems Group
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ROAD MAP

REVISIONS AND ADDITIONS TO FEBRUARY SUBMITTAL

Subsequent to the 90 day proposal submittal this volume has been expanded or changed to include system or GDHS inputs. To facilitate NASA review, additional or changed information appears only on yellow pages. The changes on each yellow page, identified by shading in the entire area of change, are on the pages listed below. Yellow colored pages with no shaded portions contain all new input.

Page	Change
	New title page
iii	Page number changes
iv	Added new items
1-2	Deleted comment
1-3 and 1-4	Word changes for classification
2-3	Word change to correct error
2-4 through 2-11	New items for software requirements
2-15	Added new Figure 2-2
2-19	Word change for clarification
2-20	Added software requirement
2-21	Changes for clarification
2-23	Added software requirement
2-24	Added software requirement
3-5 through 3-7	Added software requirement
4-2 through 4-5	Added software requirement
4-8 through 4-20	Deleted Software Development Milestone Plan. This plan is now in Proposal Part II, Volume 3 "ERTS System Development and Activation"
6-3	Corrected error
6-10	Error correction
6-14	Error correction
6-16	Error correction
6-20 through 6-24	Added software requirements

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CONTENTS (Continued)

1. FOREWORD

1.1 CONFIGURATION MANAGEMENT SYSTEM

It is TRW Systems Group policy to assess customer configuration management requirements as expressed in requests for proposal and in resulting contracts. To this assessment is added possible requirements for configuration management techniques not contractually specified but considered necessary for good business practice. The product of this analysis is then expressed in a formally published configuration management plan which is unique to each project. This policy is followed whether the plan is to be approved by the customer and contractually invoked or merely internally published on the authority of TRW Systems Project Manager.

1.2 ERTS CONFIGURATION MANAGEMENT PLAN

The configuration management disciplines and procedures contained within this plan are designed to accommodate a rigid formal system of configuration management as it applies to the spacecraft/observatory segment of the program, and a phased application of flexible informal and formal configuration management disciplines for the ground data handling system segment of the program.

1.2.1 Spacecraft/Observatory (S/O)

The spacecraft/observatory segment is a modification of the Orbiting Geophysical Observatory (OGO) and as such contains configured items (CI's) that have been qualified and flight proven. These items will be used on the spacecraft/observatory as is or will have design changes incorporated. In addition, some new items will be designed to meet the mission profile. The final OGO baseline has been modified by incorporating the ERTS configured items and by removing the OGO items which are no longer applicable to ERTS to create the ERTS Spacecraft/Observatory baseline. The configured article lists in Section 2 indicate those configured items that are subject to informal or formal configuration management.

1.2.2 The Ground Data Handling System (GDHS)

This system converts the spacecraft/observatory sensor signals to interpretable data in a form that provides maximum utility to the system

user. It also manages the spacecraft/observatory operation. It is composed of the NASA Data Processing Facility (NDPF), and the Operation Control Center (OCC). The system consists of electronic data processing equipment and its attendant software programs, photo-optical processing equipment, and facilities each being in a conceptual state of design that will progress through a design and development phase and a definition phase before becoming operational. As baselines are achieved and identified, formal and informal configuration management will be applied as required. ~~The configuration management requirements are identified within this plan only to the extent available while the detailed procedures will be included in consonance with the ground data handling system proposal schedule.~~

1.3 CONFIGURATION AND DATA MANAGEMENT (CADM)

CADM is a functional organization within product assurance: a TRW Systems Group staff organization whose director reports directly to the Systems Group vice president and general manager. As such, its services and the expertise of its specially trained personnel are equally available to all projects. CADM is also the TRW Systems Group resource that provides the necessary services for projects to manage the technical data that defines the configuration of their products. These services are provided by the following areas of speciality:

- Data services identifies, releases, documents, stores, and retrieves technical data at both a central location and service satellites throughout the Los Angeles area. It is the TRW Systems source of government publications and of company manuals.

- Data production provides a wide range of microform technologies for the distribution of data, advanced data reproduction techniques, and a large variety of services based on electronic data processing.

- Project support, by direct assignment of specialized personnel, provides TRW Systems projects with the services necessary for configuration management modified by project management and contract requirements.

In performing these services, technical data is subject to continuous data quality assurance and is transmitted from originators to users by a TRW courier service. A systems development group develops and implements systems for using organizations by combining the varied techniques of micromation electronic data processing and information systems. To ensure the adequacy and continuity of services, CADM representatives are assigned to each of the operating divisions. They act as contact points to promote smooth and cost effective relations between their organization and the projects it serves.

1.3.1 Drawing Release System

The TRW Systems Group drawing release system is as established within this plan it is further detailed in the drafting room manual (DRM). This system features the use of CADM as the single point for release of all types of engineering data for use in production of deliverable items. CADM acts on behalf of and under the direction of TRW projects with respect to their unique engineering data.

1.3.1.1 Project Release Plan

The ERTS project office will prepare a project release plan immediately upon award of contract. This plan establishes the types of data to be released, the personnel responsible for the generation of the data, the signatures required for release of both original and changed data, and the personnel authorized to withdraw original project data from vault storage for change activity.

1.3.1.2 Use of the Engineering Data Release Authorization (EDRA)

To prevent premature or unauthorized release of engineering data, the first release of engineering drawings is accomplished by sending the originals to CADM accompanied by release authorization bearing the approval signatures established in the ERTS project release plan. Information carried on the release is transcribed onto engineering data release records, which are maintained thereafter as complete and permanent records of the release status and history of each drawing.

1.3.1.3 Establishing Controlled Distribution

Distribution of ERTS drawings will be controlled by the project Configuration Management Office using the engineering data request (EDR) form. Individuals can be put on controlled distribution for all project drawings, drawings for only specified configuration items or subsystems, or individual drawings. Once such distribution is authorized, each individual will automatically receive the original issue and all revisions of data. This system ensures that the latest approved revision of ERTS drawings will reach the users of engineering data. Distribution is by a configuration and data management system of regularly scheduled mail delivery.

1.3.1.4 Standard Drawing Release System

The standard drawing release system is based on microfilming each document and each revision, mounting the film in aperture cards, and then reproducing prints by xerography. Distribution is then made of both aperture cards and prints as directed by the engineering data request using the CADM courier system.

1.3.1.5 Use of Engineering Orders (EO's) to Change Drawings

Released drawings can only be changed by means of the engineering order, approved as specified in the project release plan. Changed engineering orders may be issued without change to the face of the drawing up to a maximum of five such orders before incorporation is required. Drawing revised orders may be issued when the vellum original is changed.

1.3.1.6 Storage and Retrieval of Drawing Originals

To prevent abuse or unauthorized change to ERTS drawings, CADM has been designated as custodian of original engineering data.

1.3.2 Microfilm System for Engineering Data

CADM serves projects by providing a system for reproduction, distribution, and historical recording of engineering data which is based

on the use of 35 mm microfilm mounted in aperture cards. This microfilm system has numerous advantages over conventional drawing reproduction systems.

1.3.2.1 Quality Assurance of Engineering Data

Use of microfilm as the basic medium for reproduction places a high premium on the quality and legibility of original drawings. CADM performs a quality assurance inspection of drawing originals, exposed film, and hard copies reproduced from aperture cards. This ensures that engineering data at all points of use is clearly legible.

1.3.2.2 Control of the Microfilm Process

Drawings which are acceptable from a quality standpoint are then recorded in the release records and a microfilm work order is made in accordance with the applicable engineering data request. Aperture cards for the required distribution are then keypunched, verified, and interpreted; drawings and related changes are then filmed and mounted in original aperture cards and duplicate cards are produced in required quantities. Distribution is then made either in the form of aperture cards to all CADM service centers and to users for use in desk viewers or in the form of Xerographic prints.

1.3.2.3 Uses of Microfilm Aperture Cards

CADM maintains a master file of all TRW technical documentation of 35 mm aperture cards, including a complete history of all revisions. Branch service centers are furnished selected aperture cards for reproduction of hard copies at locations convenient to major data users, thus eliminating the need for print files. A disaster file is maintained at a location remote from the management master file. Numerous specialized files are maintained in project offices, and use of the aperture card in a desk viewer is encouraged in lieu of ordering hard copies.

1.3.3 Data Analyses and Listing

TRW standard practices established the policy of a central organization within TRW to be responsible for the generation and maintenance of engineering data lists to ensure that the processing of these lists would be automated. With one organization responsible for the management of

engineering data lists and associated lists, an official source of drawing and parts information is available to produce the engineering information required by the project office, hardware operations, integration and test, product assurance, materiel control, procurement, configuration management, launch and operational purposes. Official data lists from a central source facilitate the use throughout the company and by Systems Group customers of accurate, consistent, and timely engineering information. CADM is the established central organization for maintenance of this data bank. It produces drawing and parts lists to satisfy the needs of the various user organizations from the data bank. Drawings, engineering orders, specifications, preliminary lists of material, released or pre-released data, manufacturing documents (MSO/PALS), and purchase orders are used by CADM as source data for input to the system.

Reports may be selected from the data bank to satisfy contract or project requirements. CADM maintains the data bank on a current basis and prepares reports only as directed by the ERTS project office.

1.3.3.1 Configured Article List

Goddard Space Flight Center management instruction GMI 8040.1 requires the preparation of a configured article list of all end-item hardware and software to the black box and subroutine level to serve as the configuration status report. These lists are prepared at all baselines and for each formal test. The ERTS project office will satisfy this requirement by selective programming to the existing OGO data bank which will produce the configured article list as well as the ERTS consolidated indentured parts list (CIPL). This list is a tabulation of all parts and materials for a specific configured item and contains the quantities used, next assembly relationship, serial number change effectivity, and descriptive data prepared in top-assembly-down order. Its format is compatible with and meets the requirements of MIL-STD-100.

1.3.3.2 Data Lists

Data lists are used for summarizing formal data packages for delivery to GSFC. CADM will produce these lists as directed by the ERTS configuration management office. They include parts, data, and index lists which are available under existing computer programs.

1.4 PROJECT OFFICE STRUCTURE

The ERTS project office structure outlining the Configuration Management Office (CMO) is shown in Figure 1-1. The responsibility for configuration management lies with the ERTS project manager who is ultimately responsible for all phases of contract performance.

1.4.1 ERTS Configuration Management Office (CMO)

The manager of this function reports to the manager of performance assurance who is authorized to represent the project manager in all matters relating to configuration management. The configuration management manager has been delegated the authority to prepare and implement the procedures necessary to assure compliance with the ERTS configuration management requirements. The specific functions and responsibilities of the management office are as follows.

- Perform change administration and planning by assuring detail coordination with manufacturing, integration, and test planning so that changes to completed configured items are scheduled and have a minimum effect on integration, system, and unit testing.

- Serve as the single point of contact for all matters pertaining to configuration management requirements on the ERTS project.

- Ensure maintenance of the system specification and contract end-item specifications in accordance with such items as customer requests and contract change notices.

- Ensure that subsystem, equipment, and other TRW specifications reflect the latest requirements of the contract specifications.

- Coordinate and establish subcontractor and supplier configuration management practices to insure effective control. Conduct audits of internal TRW Systems and subcontractor/vendor configuration management practices.

- Implement internal operating procedures through the use of ERTS configuration management bulletins in accordance with this ERTS configuration management plan.

- Coordinate and establish requirements for engineering configuration data, data control and release, change processing, and configuration documentation methods to the requirements of the contract and the configuration management system for the ERTS project.

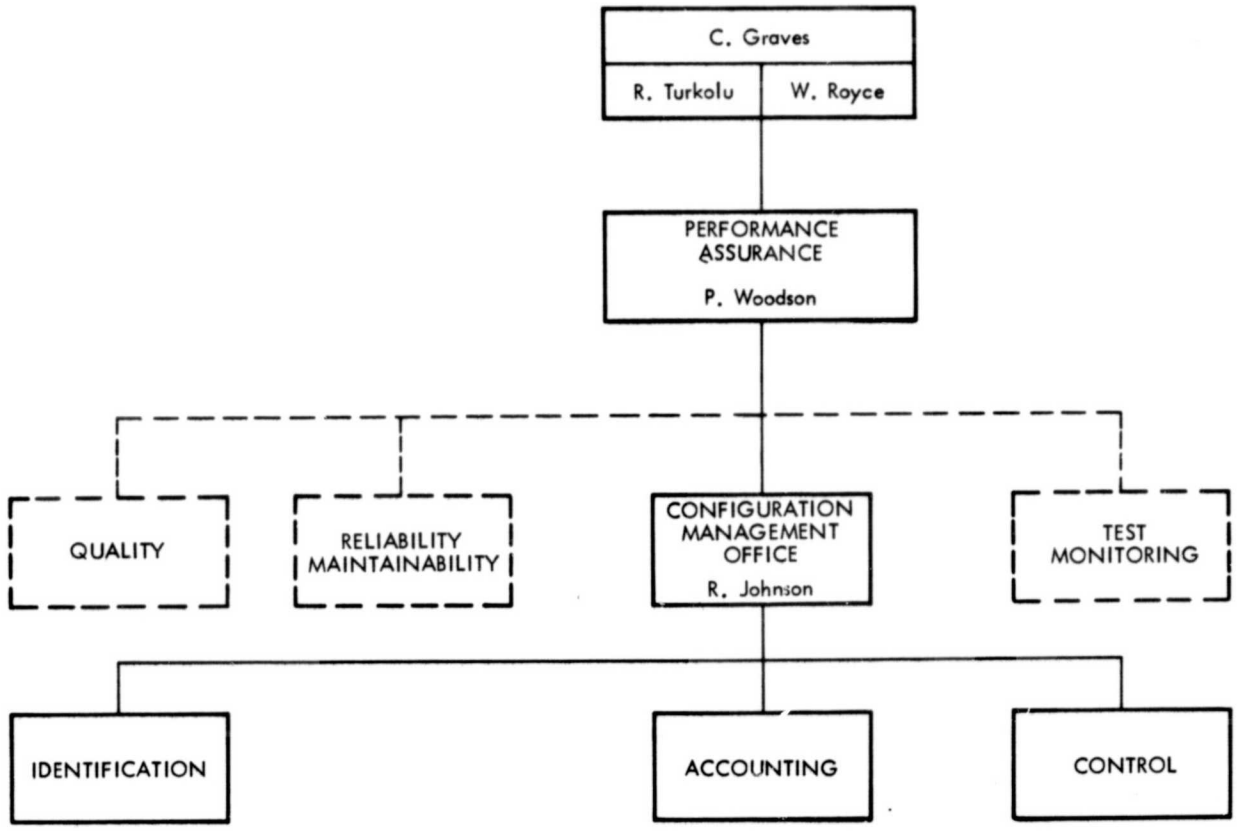


Figure 1-1

PROJECT OFFICE RELATIONSHIP

- Prepare and maintain the configuration management plan, its implementation procedures, and operating instructions.
- Administer the change evaluation and control board operations for proper evaluation of proposed configuration changes and establish detailed change board procedures and instructions.
- Establish requirements for the maintenance of drawings, specifications, and supporting data trees for each configured end item.
- Review test procedures and changes thereto to determine that the testing complies with the parameters in the latest approved TRW and contract specification.
- Review changes for systems compatibility and reliability to provide assurance that the interchangeability of configured end items is not affected.
- Conduct periodic surveys to determine the effectiveness of configuration management practices.
- Review and monitor configuration verification records.
- Support project design and customer reviews.

2. CONFIGURATION IDENTIFICATION

2.1 ERTS CONFIGURATION IDENTIFICATION

Configuration identification is a task of defining the methods used to manage and segregate the technical documentation that is used to design, fabricate, test, and deliver the total ERTS System.

2.1.1 Configured Article Lists (CAL's)

Preliminary configured article lists defining items under the informal and formal change control requirements of GMI 8040.1 are shown in Tables 2-1 through 2-3a. The lists will be published in final drafts early in the phase D contract:

- The preliminary Stage 1 configured article list identifies those items that are in a development state and as such are subject to informal change control requirements.
- The preliminary Stage 2 configured article lists includes configured items that are provided for ERTS usage in their present design configuration and as such are subject to formal change control disciplines.
- The preliminary Stage 2A configured article lists includes configured items that require minor design modification and as such are exposed to an informal change control discipline on the minor redesign task; however, the remaining basic design will be controlled rigidly.

2.1.2 System Identification

Identification of the ERTS system, including both the spacecraft and the GDHS, is accomplished by a "total" system specification that also serves as the overall contract performance specification.

2.1.3 Spacecraft System Specification

The spacecraft system specification is the identification and performance specification that defines the spacecraft subsystems and interface requirements. It defines the general performance and design requirements of the payload interface as well as the spacecraft subsystems.

Table 2-1. Configured Article List Stage 1, Informal Baseline Control

End Item Nomenclature	Specification Number	Drawing Number	Intended Use	Configured Item
Orbital switch assembly	D-13522	To be assigned	ERTS-A and-B	To be determined
X reaction wheel	D-13376			
Y reaction wheel	D-13376			
Payload bus converter	D-13486			
Return beam vidicon battery	D-13487			
Stored command programmer	D-13541			
Wideband telemetry transmitter driver	D-13388			
Video channel switch assembly	D-13492			
Traveling wave tube amplifier	D-13419			
Unified S-band and wideband shaped beam antenna	D-13544			
Unified S-band transponder	D-13493			
Dual baseband assembly	D-13394			
Unified S-band diplexer	D-13545			
Unified S-band omni-antenna	D-13542			
VHF transmitter	D-13494			
Wideband, band reject filter	D-13543			
VI thrusters	D-13521	To be assigned	ERTS-A and-B	To be determined

Table 2-2. Configured Article List Stage 2, Formal Baseline Control

End Item Nomenclature	Specification Number	Drawing Number	Intended Use	Configured Item
Yaw gyro assembly	D-13371	201371-1	ERTS-A and-B	To be determined
Rate gyro assembly	D-13372	200935-1		
Inverter assembly	D-13378	C207540-2		
Control switch assembly	D-13385	228576-3		
Array drive mechanism	D-13381	202540-2		
Array position transducer	(Kearfott)	C200979-1		
Pneumatic assembly	D-13379	C111928-1		
Valves	PT2-3002	243553-1		
Pressure switch	PT2-3003	Hydra Electric		
Pressure regulator	PT2-3004	Sterer		
High pressure transducer	PT2-3000	Servionics		
Low pressure transducer	PT2-3001	Servionics		
Battery pack	D-13402	232820-2		
Charge control assembly	D-13403	204553-2		
Converter no. 2	D-13405	C206566-1		
Converter no. 5	D-13405	C206569-1		
Converter no. 7	D-13405	C206805-1		
Converter no. 9	D-13405	C206570-1		
Digital data handling assembly	D-13424	218486-1		
Momentum control assembly	D-13483	247072-1		
Digital integration unit	D-13461	231394-1		
Solar array drive shaft	D-13381	100669-2	ERTS-A and-B	To be determined

Table 2-3. Configured Article List Stage 2A, Modified Formal Baseline Control

End Item Nomenclature	Specification Number	Drawing Number	Intented Use	Configured Item
Horizon scanner	D-13373		ERTS-A and-B	To be determined
Sun sensor	D-13374	202384-1		
Sensor electronics and logic assembly	D-13375	200932-2		
Attitude control assembly	D-13377	200833-1		
Drive electronics assembly	D-13380	200934-1		
Z reaction wheels	D-13376	218461-1		
Nozzle booms	PT Spec	N/A		
Solar paddle	D-13362	100010-11 and 12		
Power control unit	D-13481	232215-2		
VHF receiver	D-13471	217907-1		
VHF dual diplexer assembly	D-13472	218264-2		
VHF command decoder	D-13416	218303-1		
VHF antenna	D-13412	217530-1		
Specific purpose telemetry	D-13456	202650-2		
VHF power monitor	D-13458	214252-2		
Analog digital handling assembly	D-13422	201140-1		
Signal conditioner	D-13455	201738		
Tape recorder transport	D-13423	207464-5		
Tape recorder electronics	D-13423	207463-2		
Command distribution unit	D-13406	201529-3		
Junction box, central 3A5	D-13461	222518-1		
Junction box, power distribution 3A7	D-13461	222518-2		
Junction box ordnance 3A13	D-13461	214055-1		
Low frequency timing assembly	D-13475	218487-1		
Solar array wrap-up	D-13489	232443		
Spacecraft structure	D-13361	107997-5		
Louver banks	D-13391	104017-10	ERTS-A and-B	To be determined

Table 2-3a. GDHS Configured Article List

End Item Nomenclature	Specification Number	Drawing Number	Intended Use	Configured Item

To be supplied in Phase D

2.1.4 GDHS System Specification

This specification is the identification and performance specification that defines the GDHS, its related subsystems, and their interface requirements.

2.1.5 Subsystem Specifications

The design and performance requirements of each individual subsystem are defined by the subsystem specifications. They also identify the individual equipment and/or software specifications that comprise the subsystem.

2.1.6 Equipment Specifications

The equipment specifications are the lowest level of specification identified to project requirements. They define the designs, performance, and quality requirements of each configured item of hardware.

2.1.7 Computer Program Configured Item (CPCI) Specifications

The computer program configured item specifications are the design of a computer program, module, or routine and are defined below.

2.1.7.1 Computer Program Design Specifications

The computer program design specifications provide a general description of the entire ERTS GDHS software subsystem and a complete engineering description. Programming will be based on this specification.

The design specifications become the approved basis, complete with all information, required to generate the coded statements that comprise the delivered computer programs with the capabilities specified in the approved Milestone B's of the ERTS development milestone plan. They also serve as a baseline description for operations or for supporting personnel to use in association with the proper computer program listing to diagnose problems or to integrate changes into the software. The design specifications are based on approved Milestones B and C of the ERTS development milestone plan and, when it is approved, encompasses and supersedes Milestone B.

Milestone D covers the entire ERTS GDHS software subsystem. It consists of the following documents:

- ERTS GDHS software subsystem overview
- Function design specifications
- Module design specifications
- Routine design specifications.

The contents of these are listed below. Test plans and procedures are documented separately in the acceptance and test specification. Operating instructions are documented in the automatic data processing software operations manual.

- Subsystem flow diagram: a top level function and interfacing subsystem flow diagram that shows how data flows within the subsystem.

- Inputs and outputs: a general description of the input and output categories, including input sources affecting the subsystem and output categories and their destinations. All manual inputs are identified.

- Interfaces: a general description of all external system hardware and software interfaces, including remote data links, executive/utility software, ephemeris data, environmental data, DSL user interface, and telemetry interface.

- Operating concepts: an overview of how the subsystem operates, with a list of pertinent assumptions and conditions. A timeline shows how the ADPS functions are used in typical operations in the GDHS. Subsystem disk and core storage requirements and run time are summarized from the function descriptions to show their distribution in the subsystem.

- Restrictions: the more important subsystem restrictions and limitations, e.g., archives limitations, command message lengths, data base limits, and data reporting and transmission restrictions.

- Equipment configuration: the ADPE configuration required to operate the subsystem. The schematic diagram shows equipment item model numbers and the interconnections. Input data entry equipment and data output devices are identified and keyed to data category sources and destinations.

Bibliography

The bibliography is an alphabetical list of all references applicable to the Milestone D document set; it is referenced by all documents in the set.

2.1.7.2 Module Design Specification

A module design specification is published for each module within the software subsystem. These documents show relationships between modules and routines in module-level flow diagrams as applicable. Included are a functional description of each module and routine, data table usage, input and output parameters, card formats if applicable, core requirements, timing data, and module limitations. The level of detail defines the design of the routines in each module design specification. The format of the module design specification for each module is as follows.

Title page

Table of contents

Glossary of terms, abbreviations, and symbols

a) Purpose

A brief explanation of the module's tasks and functional utility.

b) Description

The module data flow, purposes, organization (including a list of the associated routines and a brief functional description for each) and its environment. Basic logical concepts, capabilities, and options applicable to this module are included.

c) Usage

An overview discussion of each routine's use in the module, including its operational utilization concepts, core requirements, and run time data. Core requirements include a description that shows how its routines and required program environment occupy the available core storage and what portion of available core storage is utilized (estimates of core requirements are required with Milestone D). Module peripheral storage requirements are stated with a discussion of their effects on the module design, including the data and scratch storage allocated to disk and to tape. Allocation of all data and program storage is made between disk and tape equipment in such a manner as to prevent unplanned disk overflow to tape.

d) Flow Diagram

A diagram of the relationships among the routines that comprise each module in this function. Included are the interfacing functions to show each module's place in the subsystem.

e) Inputs

A general description of the inputs required by each module. Details required to code are in the routine design specification.

f) Outputs

A general description of the outputs produced by this module. Details required to code are in the routine design specification.

g) Interfaces

A description of the external hardware and software interfaces applicable to this function. All standard software library modules employed by each applicable function are listed.

h) Restrictions

A description of the restrictions and limitations applicable to this module. Timing constraints and core storage limitations are included as applicable.

Routine Design Specifications

A routine design specification is published for each routine within each module. Routines used by more than one function can be documented separately. Routines that comprise a module and apply to a particular function may be documented together if practical. These documents contain the detailed design data required to code the routines. The format of the routine design specification for each routine is as follows.

Title page

Table of contents

Glossary of terms, abbreviations, and symbols

a) Identification

The title of this routine and its identifier. Updated documents contain the modification (version) of the routine to which this edition of the document applies, thereby keying the document to a particular compilation. The author's name is shown.

b) Purpose

The functional task performed by this routine is described

c) Description

A narrative explaining the routine's data flow, purposes, organization (including a list of its subroutines with brief descriptions of their functional use), and environment. Utilization considerations, design concepts concerning computation accuracies, and a one-sheet flow diagran to the subroutine level are included as applicable.

d) Limitations

All restrictions and constraints applicable to the routine are listed, including those due to algorithms and equations employed, input and output data volume limits, processing techniques, and error checks and corrections made or not made.

e) Inputs-Outputs

The inputs and outputs for the routine are specified by computer program symbol, brief descriptions, units, computer program format (integer or floating point, largest number possible, and degree of significance provided), engineering symbol if applicable, and cross reference to the data definition specification. This allows reference to sources, destinations, data set and use, data table and block assignments, and other pertinent information.

f) Method

A step-by-step explanation of the processes and mathematical methods in the sequence that are used by the routine. Included as appropriate are descriptions of routine logic, data flow, design concepts concerning timing and computation accuracy, equations, algorithms, and any special characteristics or operating conditions. Discussion is keyed to the routine flow diagram. Equations are derived or their derivations reference.

g) Interfaces

Relationships with the calls to and by other routines in the subsystem are identified. All standard library routines to be used in conjunction with this routine are listed by name and identifier with use to or relation with this routine. Interfaces with equipment and programs being developed by other contractors or agencies are identified and described.

h) Coding Information

A description of data useful to a programmer for coding this routine. The following is included as a minimum.

- Storage requirements: a description of the core storage requirements for this routine, including the program and data environment, with a discussion of how size estimates were derived.

- Timing: a description of routine execution time data with a discussion of how the timing data was derived. Timing values are stated in some convenient form such as: minimum, maximum, and expected average or tables of parametric values showing key data versus run time. When otherwise legal input values of certain parameters may violate running time constraints, these parameters and suggested input values are called out separately. Routine storage and timing data are summarized at the function and module levels in the appropriate documents.

i) Subroutines

Each subroutine is specified by a flow diagram, purpose, input-output, calling sequence, author, and date that it was last documented or revised. All further information required for an experienced programmer to code the subroutine is stated in the section devoted to that subroutine. In particular, the flow diagram of the subroutine shows all logical operations and computations in a manner consistent with the subroutine's computational sequence and the established flow charting conventions explained in the software specification. Computer program labels are shown to identify entrances and exists, as practical, thereby keying the flow chart to the program listing when it is coded and compiled. The flow chart is annotated wherever necessary.

2.1.7.3 Data Definition Specification

The data definition specification defines the software data base, including identification of each data block, file, table, array, item, internal symbols, program symbolic descriptors, nominal or typical values, range restrictions as pertains to usage, internal-external units, engineering symbols, and complete engineering descriptions.

The specification is used as the defining standard for all data processed by the subsystem down to the level of the routine. As a design document it provides the data structures baseline and is used by programmers as the primary source of data definition and relationship information. As a delivered product it serves as the sole source for precise definitions of data items (constants, variables) arrays, tables, and blocks.

The data definition specification contains, as a minimum, the following information.

Title page

Table of contents

a) Introduction

A description of scope and application, as well as applicable information on organization, content, and use of the document.

b) Glossary and Bibliography

A glossary of terms, abbreviations, and acronyms peculiar to the document and a bibliography of referenced material within the document.

c) Data Sizing

Data storage requirements as a function of the storage medium, i. e., disk, drum, or magnetic tape.

1) Total auxiliary storage is allocated to the various categories of auxiliary storage use as follows:

- Executive and utility requirements (obtained from Milestone C) as a total storage requirement (not broken down by routine or data block)
- Applications software in terms of requirements for data base directory; routines, by routine
- Data base by data block
- Scratch storage requirements, by amount used, type of storage media, and the reserve available

2) Total magnetic tape storage is allocated on a function-by-function basis, including requirements for the software executive. For each function, the number of tape drives required and the purpose of each are specified.

Allocation to disk storage, drum storage, and magnetic tape is based on both nominal and maximum storage situations. The assumptions which enabled detailing of the allocation are stated. Data accumulation for assessment of storage requirements is identified as a function of data purging frequency for each type of data that is retained on any storage medium.

d) Executive Data Blocks

Identification of all data blocks maintained by the executive that are required by the application programs.

e) Detailed Directory

For all levels of data definition, information is presented for cross indexed so that the reader can find descriptive information on a block, file, table, item (constant or variable) or array by the following means:

1) Alphabetically
2) Parent interface (i. e., find table by knowing item name)
3) Setting or using routine
4) Setting or using function

f) Indexing

Multi-record blocks, file structures, and complex data index relationships are described explicity as they pertain to core, disk, drum, or tape.

g) Precise Data Definition

For each data element (block, file, table, item, array) there is a precise description of the data, including format bit structure and appropriate symbolic descriptors. Each item or array component is also described by:

1) Nominal or typical values
2) Range of values and source of restriction with respect to operator usage (e. g., the restriction might be computer hardware, functional, physica, or data structure)
3) Input, internal, and output units
4) Engineering symbols (if applicable)

2.1.8 Configured Item Numbers

These numbers are assigned to all elements of a hardware or software system (usually the black box level on hardware systems and/or a subroutine level on software systems) that require the application of configuration management and are separately identified as contract end-items to be developed, fabricated, tested, accepted, delivered, and maintained as individual items.

2.2 ENGINEERING DRAWING IDENTIFICATION

TRW Systems Group drawings prepared for the ERTS project will be identified under a numbering system which is detailed in the TRS drafting room manual (DRM). Six digit "basic" numbers are assigned by CADM to the various operating divisions in blocks. A limited number of alphabetic prefixes which signify the type of drawing are authorized for use in drafting room manual, Section 8.1. Two prefixes are permitted when contractually appropriate to denote the use of the drawing,

i. e., "X" for experimental project work and "D" for development work. All other identification elements on TRW drawings, such as nomenclature and the manufacturer's code identification number, are in accordance with MIL-STD-100.

Part numbers are constructed by the addition of sequential numeric dash number suffixes. Each part number therefore contains its corresponding drawing number, so that parts can be readily identified to the controlling drawing.

2.2.1 Forms and Categories of Drawings

The TRW drafting room manual established three forms of drawings conforming to the forms defined in MIL-D-1000. The standard drawing for deliverable configuration items corresponds to Form 2 of MIL-D-1000. A complete set of drawings for an ERTS hardware configuration item will correspond to the intended use Category E of MIL-D-1000 (reprocurement of identical items).

2.2.2 Drawing Changes

ERTS drawings, once they are released by project approved engineering data release authorization, can be changed only by the use of an engineering order (EO). These change documents are prepared by the personnel responsible for original design and are subject to the same approval signatures established in the project release plan. Three types of engineering orders can be issued:

(1) Engineering orders are unincorporated on the face of the drawing to which they become an attachment until they are incorporated.

(2) Drawing revised orders describe changes made on the vellum original.

(3) Expedited orders are unincorporated changes issued on a carbon padded form which provides copies for manufacturing and quality assurance in advance of the standard release cycle. They are used only in emergency situations prior to product baseline.

2.3 SPECIFICATION IDENTIFICATION

The ERTS specification trees are shown in Figures 2-1 through 2-3.

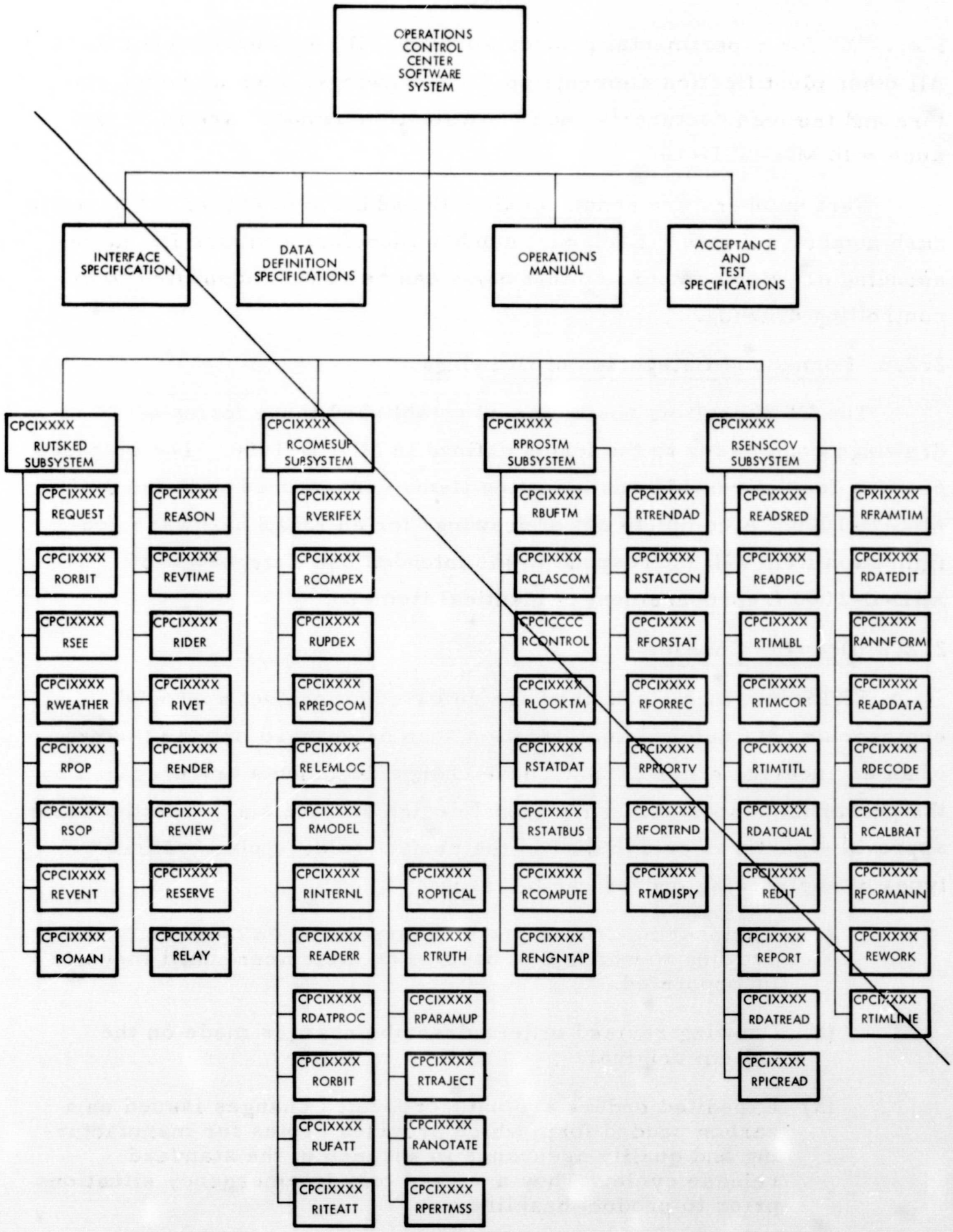
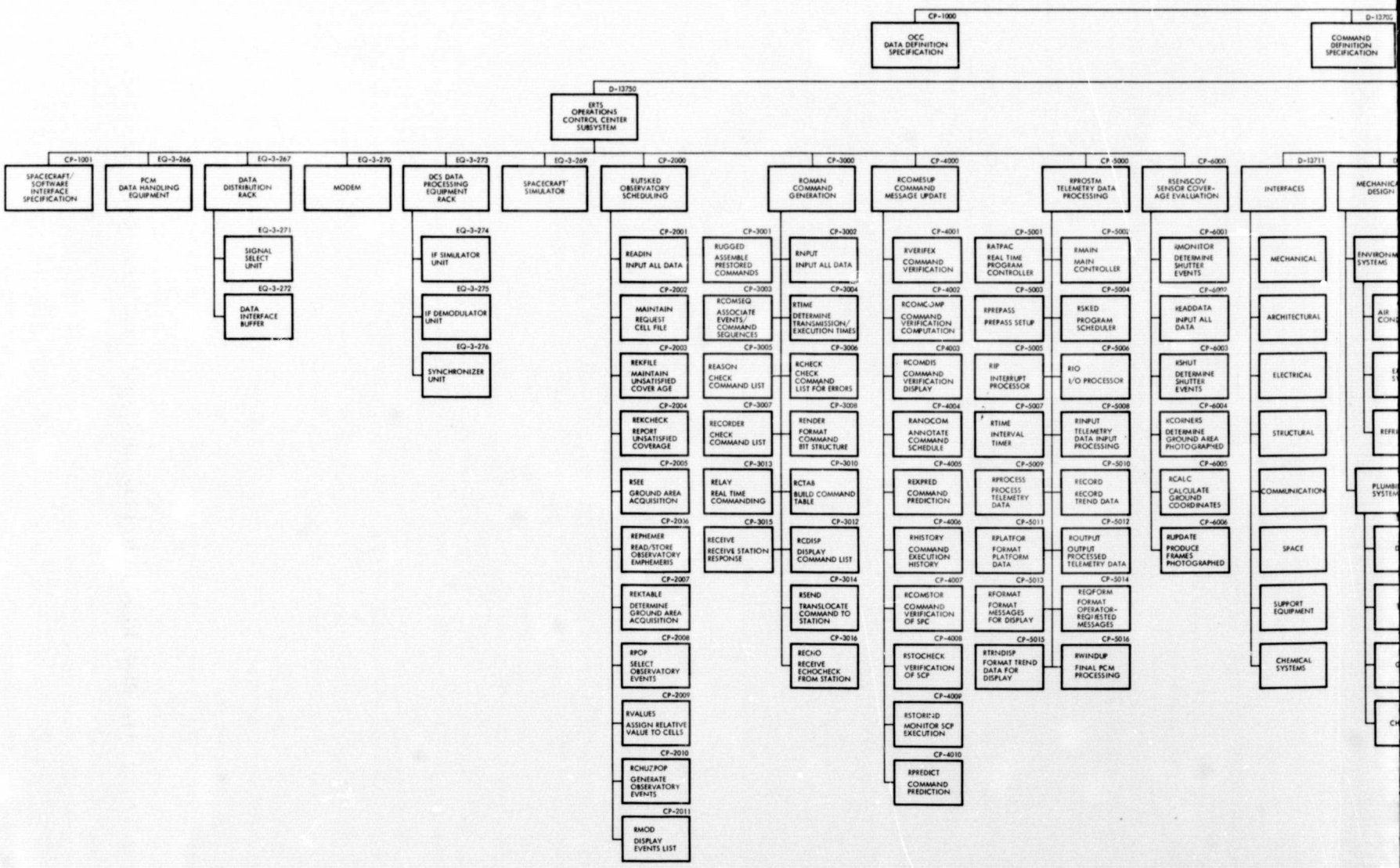


Figure 2-1

ERTS SPECIFICATION TREE



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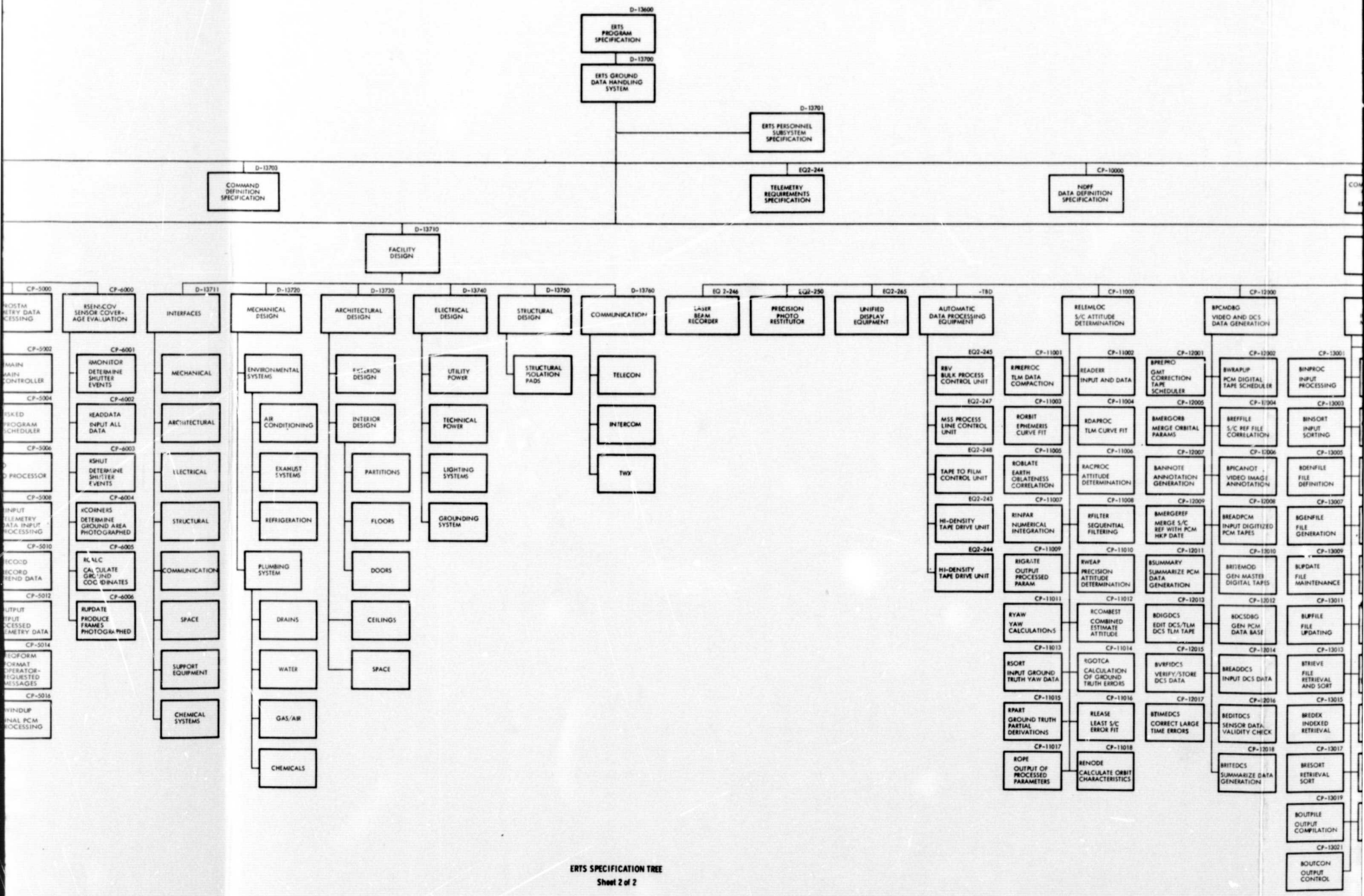

ERTS SPECIFICATION TREE
Sheet 2 of 2

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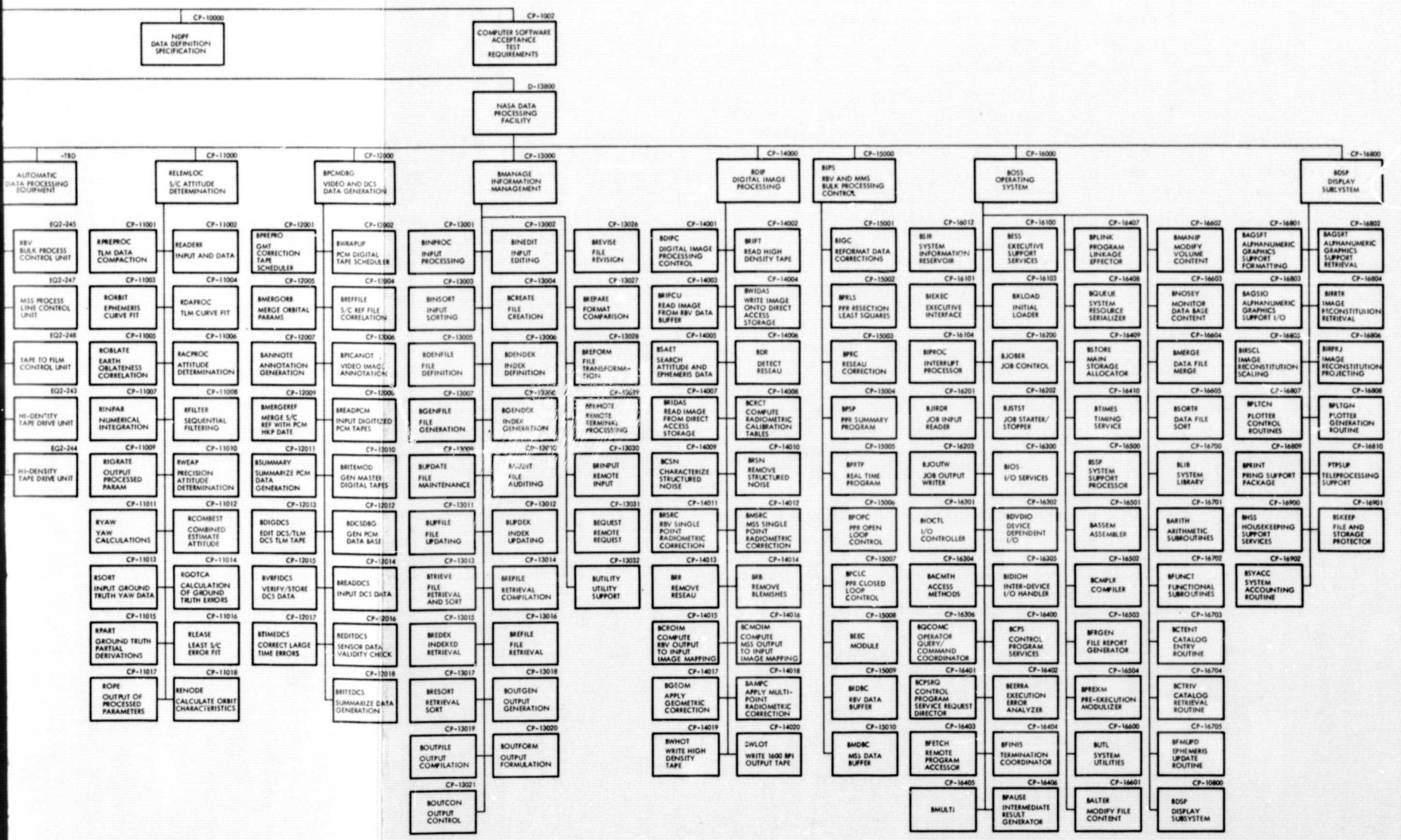

Figure 2-2

ERTS SPECIFICATION TREE

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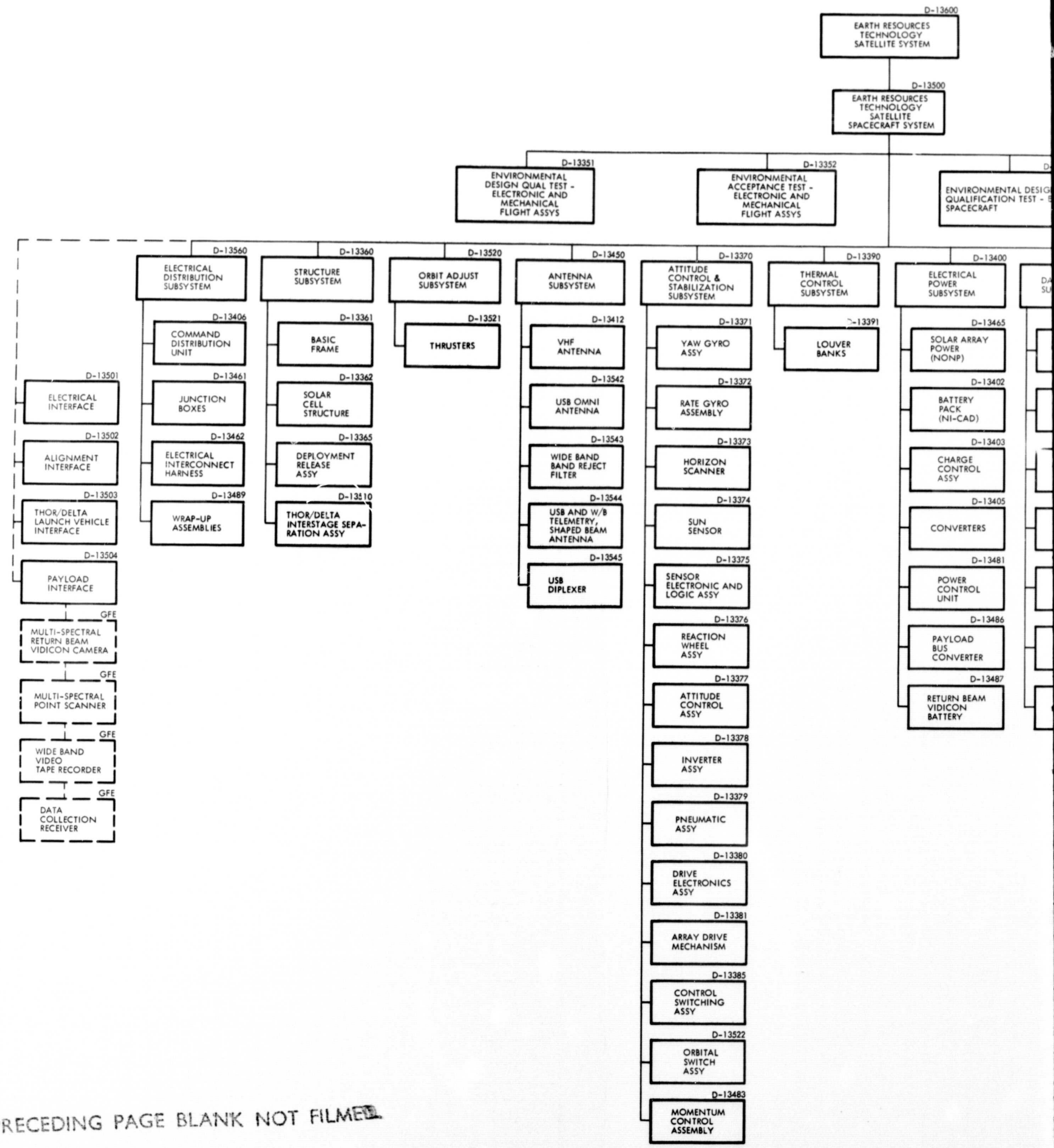

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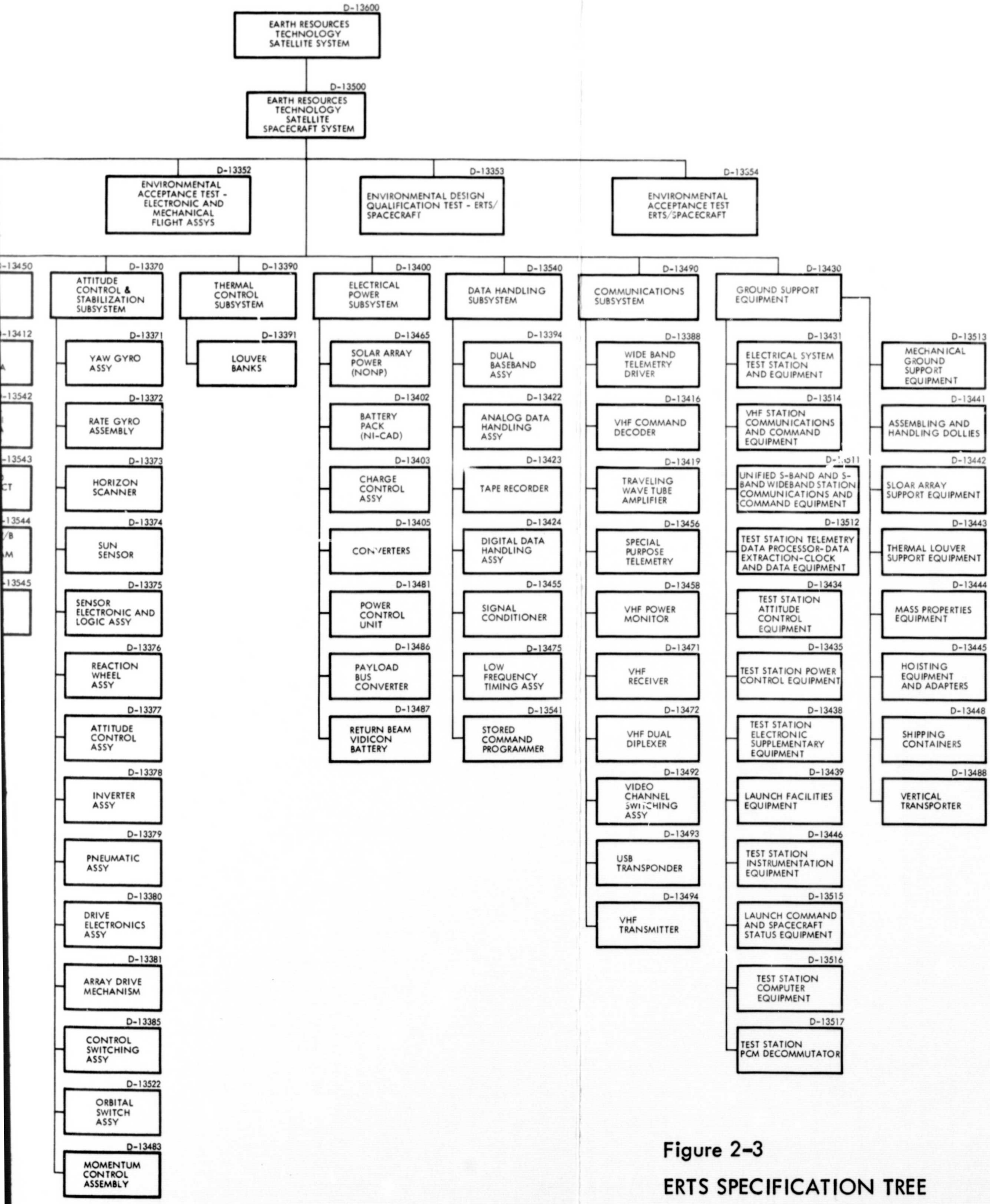


Figure 2-3

ERTS SPECIFICATION TREE

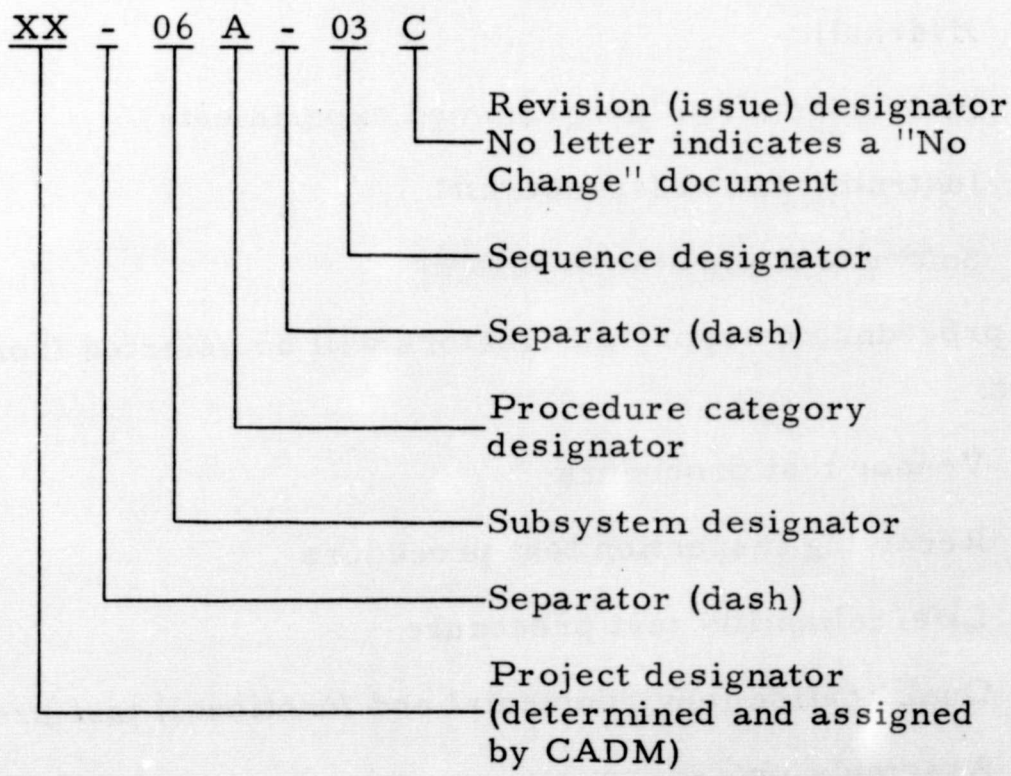
The specification numbering system assigned to the ERTS program is an extension of the OGO numbering system which utilizes a "D" prefix and a five digit numerial suffix. All specifications that are common between OGO and ERTS retain the same identification number and additional numbers are assigned by the Configuration Management Office when required.

2.4 TEST PROCEDURE IDENTIFICATION

It is a practice to generate test procedures for each system, subsystem, or equipment for which testing is required to demonstrate the achievement of the design/performance requirements of a specification. These procedures are formally released and controlled documents, subject to all the disciplines of informal and formal configuration management under the cognizance of the ERTS configuration manager.

2.4.1 ERTS Test Procedures

Hardware test procedures are identified by a composite alphanumeric designation discretely identifying one test procedure. Part of the procedure title shall identify the procedure to an equipment category such as part, assembly, and unit. Separate parts of the designation individually identify project, system, test category, test procedure sequence number, and issue of the procedure.



The example shown identifies the third released revision of test procedure sequence number three of an acceptance test on the communication system on the program designated XX.

ERTS subsystem designators will be selected from the following list:

00 Any combination of the following subsystems

01 Structures and satellite

02 Thermal

03 Power and electrical distribution

04 Attitude control

05 Communications and data handling

06 Payload

07 Electrical GSE

08 Mechanical ground support equipment

09 Electrical ground support equipment

10 Not used

11 Ground operational equipment

12 Hydraulic

13 Instrumentation (programmed experiments)

17 Instrumentation (spacecraft)

19 Software (computer program)

ERTS procedure category designators will be selected from the following list:

V Vendor test procedure

R Receiving inspection test procedure

L Life/reliability test procedure

Q Qualification (environmental and functional) test procedure

B Assembly procedure

P Operating procedure

C Calibration test procedure

PR Production test procedure

A Acceptance test procedure (environmental and functional, including calibration and validation at the contract end item, system levels, and launch).

S Integration test procedure (spacecraft or spaceborne prime equipment)

G Integration test procedure (ground support equipment)

E Integration test procedure (ground tracking equipment)

M Operation and maintenance (handling, shipping and storing, reassembly and disassembly, and preparation for test)

T Special test procedure

Procedure sequence numbers will be requested from Configuration ~~Administration~~ and Data Management by the procedure originator prior to preapproval coordination of such procedure. At the time of such request, the requester will provide configuration administration with the procedure, title, project, system designation, test category designation, and anticipated date of release of the procedure. Upon receipt of the preceding information, configuration administration personnel will provide the requester with the next unused procedure sequence number applicable to that project. In the event a procedure having an assigned number is cancelled before it is released, CADM must be immediately notified of the cancellation. When a procedure is prepared that combines two or more previously numbered procedures into a single document, the resulting procedure will be reidentified.

~~2.4.2 Software Test Procedure Identification~~

~~To be supplied with final proposal, April 1970.~~

2.5 BASELINE IDENTIFICATION

Baseline identification on the ERTS project is compatible with GMI 8040.1 Stage 1 and 2 baselines. The configured items that are subject to the disciplines of the two baselines are identified by the inclusion of their drawing/part-number in the respective configured article list.

2.6 CHANGE IDENTIFICATION

Changes originated on the engineering change request form, irrespective of the baseline status of the affected configuration item, require a means of identification to permit recording and tracking of their status. TRW Systems Group employs a master change number (MCN) as the means of identification and as a device for packaging changes affecting more than one engineering document or configured item.

2.6.1 Master Change Number (MCN)

Master change numbers are used to control TRW engineering change identification and packaging. A master change number is assigned to each engineering change request as soon as it is processed; the number is retained throughout the entire change process.

Once assigned, engineering change package numbers cannot be reassigned even though the requested change is disapproved. All engineering data and directives, as well as planning, manufacturing, procurement, and other pertinent documentation generated as a result of an approved change are identified by the master change number.

Example: XX 115 010 007

- 007 — CI sequential change number (7th sequential change to CI-010)
- 010 — CI number
- 115 — Change package number (115th sequential change to the CEI)
- XX — Project designator

Since in many cases a change to one configured item necessitates a change to others, the master change number is also used to identify the total changes resulting from any one change.

Typical change package

A-115-4155-007

A-115-5135-011

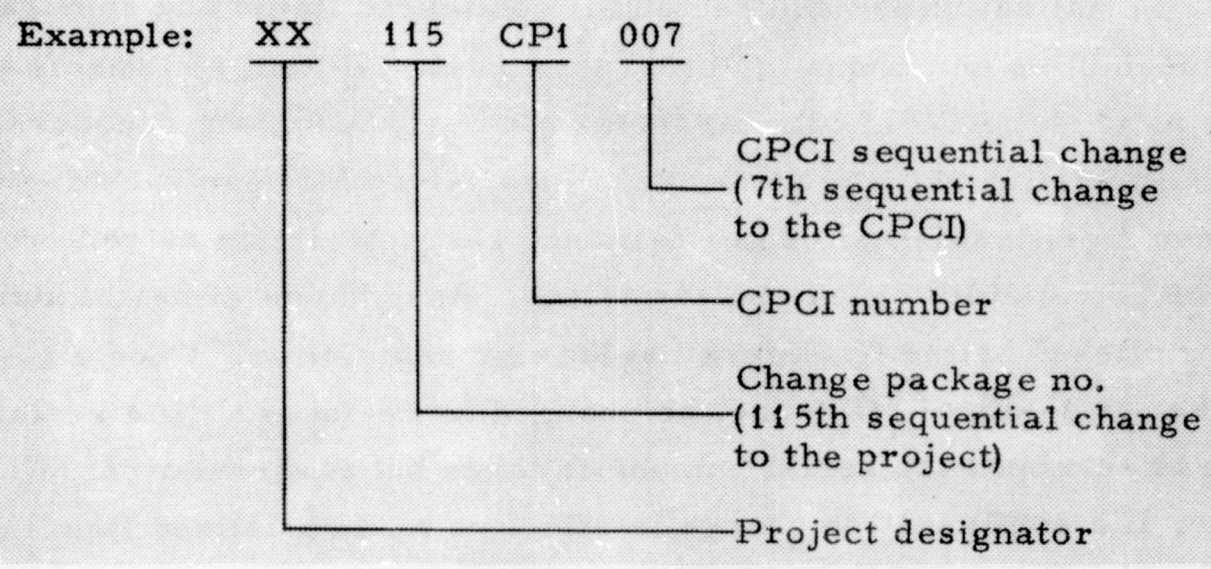
A-115-6140-006

A-115-7125-027

This example indicates that the seventh change to item 4155 also necessitates changes to other configured items -5135, -6140, and -7125.

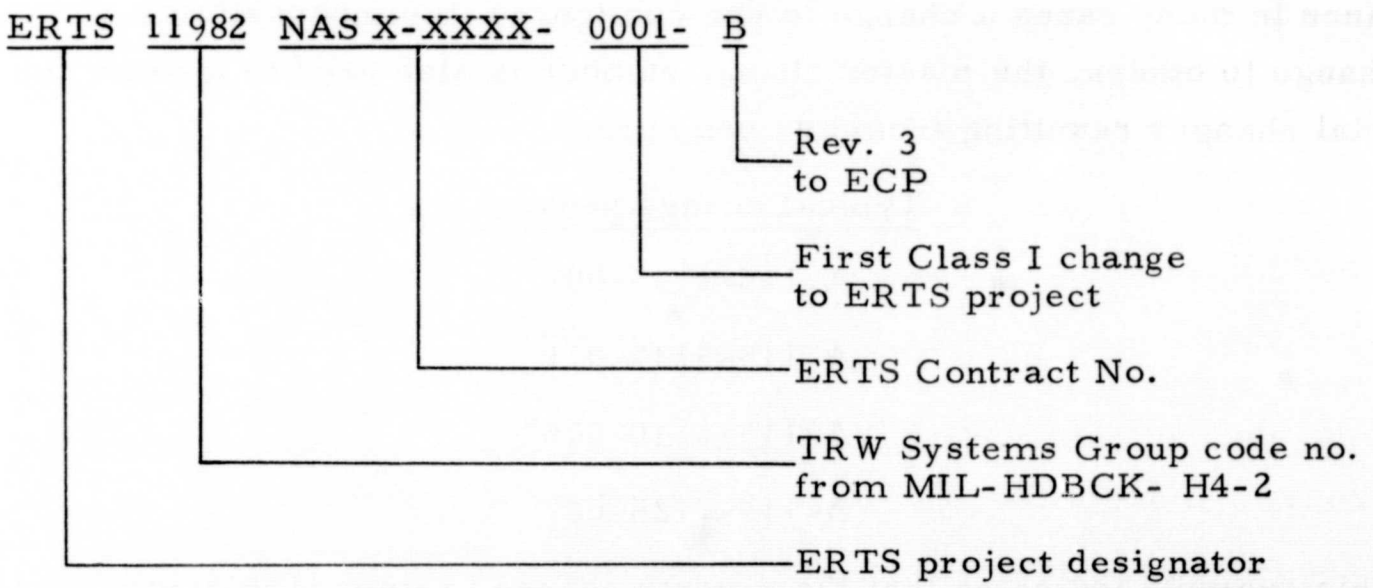
The Configuration Management Office is responsible for ensuring that changes affecting multiproject usages or multiconfigured item usages are identified and appropriately processed, using the same project number.

2.6.2 Change Identification (Computer Program Configured Items)



2.6.3 Engineering Change Proposal Identification

Identification of the change proposal is accomplished by assigning a composite alpha numeric designation that discreetly identifies the engineering change proposal to the ERTS project and to TRW Systems Group. Separate parts of the designation individually identify (a) ERTS project, (b) TRW Systems Group, (c) contract number under which the ERTS is being developed, (d) consecutive number of the change and (e) revision of the engineering change proposal.



2.7 SERIALIZATION

Serialization is a means of traceability by which end products and their components are related to respective design criteria and performance history. Serialization also includes the establishment of criteria and methods for marking hardware and software configured items and their respective subassemblies and/or components.

Serialization is required on all configured items and repairable subassemblies and computer program configured item software/hardware such as tapes, EDP cards, computer binary subprogram decoders, computer symbolic subprogram decks, discs, etc. All components considered to have a critical effect on performance characteristics as referred to in the ERTS reliability plan are serialized. Assignment of serial numbers is accomplished by the Configuration Management Office. Once a serial number is assigned, it cannot be changed or re-issued. If a serialized item is scrapped the serial number is taken out of circulation. Furthermore, if a configuration change is effective on a serialized item that requires a part number change, the serial number of the item will remain the same in all cases. Serial numbers will be located on the serialized item as near to the part number as possible, and in such a location so as to be visible after installation.

Product marking will be accomplished in accordance with the requirements stated in the applicable design specification and the engineering drawings.

3. CONFIGURATION ACCOUNTING

Configuration accounting is the effort involved in the accounting of the items specified in Section 3 of this plan and involves the publication and issuance of reports emanating from the operational divisions and supporting functions as well as the ERTS Configuration Management Office. Some of these reports are produced under normal divisional working parameters, and as such, when combined with other information will satisfy the requirements for configuration accounting on the ERTS project.

3.1 INDENTURED DRAWING LIST - PRELIMINARY LIST OF MATERIALS AND ADVANCE LIST OF MATERIALS

Each subproject/design area will prepare an indentured drawing list (IDL) and a preliminary list of materials (PLM) or an advance list of materials (ALM) which will include a schedule of drawings to be modified or generated and a schedule for completion. These lists will be maintained in a contemporary status until the drawings are released.

3.2 CONFIGURATION ITEM IDENTIFICATION LIST (CIIL)

The identification list will be published and updated on an as-required basis. It lists by subsystem and unit the configured items within each subsystem (hardware) and unit (software) and includes the following information.

- Configured item identifier or computer program configured item identifier
- Configured item drawing number
- Configured item description
- Configured item applicable specification number
- Responsible unit engineer or programmer

3.3 CONFIGURED ARTICLE LIST (CAL)

The article list (see Section 2) of end-item hardware and software defining all configured items and computer program configured items that are under Stage 1 and Stage 2 baseline controls will be up-dated on an

as-required basis and at the time of each formal test. As a minimum the lists will contain:

- End item nomenclature
- Applicable specifications
- Current engineering drawing revision and date of issue
- Applicable interface control document
- End-item usage
- Current location of the end item

The configured article list will also serve as the baseline for spacecraft assembly, integration, and test, and as the detailed sell-off list for the D D-250 documentation pcakage on all configured items.

3.4 ERTS A&B FLIGHT REPORT

The flight report containing the configured item number, drawing number, nomenclature, drawing revision number, and serial number of all flight items that are launched on the ERTS A and B will be published and distributed within ten days subsequent to each launch.

3.5 CHANGES PENDING REPORT

Changes pending report will be generated and maintained by the ERTS Configuration Management Office. It reflects outstanding change actions required of all parties necessary to close-out and complete related changes to affected change documentation.

3.6 CONFIGURED ITEM ASSEMBLY LIST (CIAL)

The assembly list is obtained from the consolidated indentured parts list data. It lists the major subassemblies within each configured item but does not include a number of standard parts such as tapes, bolts, nuts, rivets, solder, and I.D. plates.

3 7 DAILY ENGINEERING DATA RELEASE BULLETIN

Configuration and Data Management (CADM) publishes a machine-prepared bulletin which is distributed to personnel having a need-to-know as directed by the ERTS Configuration Management Office. This

bulletin indicates to users of engineering data all those documents and revisions which have passed through the release point during the preceding 24 hour period. The bulletin groups the data by types, e.g., new drawings, engineering orders, specifications, and specification change notices and indicates the project using the data. The daily engineering data release bulletin provides a useful service by informing TRW Systems Group personnel performing on the ERTS project that specifically identified data is now available at the nearest CADM satellite service center.

3.8 CONSOLIDATED INDENTURED PARTS LIST (CIPL)

The parts list is an indentured listing of configured items to the lowest indenture level of assembly. It includes the applicable specifications and test procedures as well as the code identification for purchased parts.

3.9 SYSTEM PARTS ACCUMULATION INDEX (SPAI)

The index is an alpha-numeric order computer printout of all parts and applicable specifications and procedures in a given system. It is obtained from the same data used to produce the consolidated indentured parts list.

3.10 CONFIGURATION VERIFICATION OF CONFIGURED ITEMS

Verification is an assurance task of comparing the as-designed configuration (defined by the engineering drawings and related documentation and recorded on the assembly list with the as-built configuration of a product. It is accomplished on the ERTS project for all configured items produced by TRW Systems Group, including the ERTS spacecraft. The system is managed by the Configuration Management Office and involves the efforts of manufacturing, CADM, engineering and quality assurance.

3.10.1 Design Information

As designed information is recorded in the configured item assembly list and distributed to appropriate personnel in manufacturing, planning, and quality assurance. The CIAL is updated as changes occur through the

issuance of baseline change reports; thereby, manufacturing and quality assurance are advised of the latest configured item design baseline at all times.

3.10.2 Manufacturing Information

Manufacturing information arrangements have been made with manufacturing and material managers to obtain the as-built configuration of configured items. This information is obtained in various ways from different areas, but the validity of the information is the same.

- Electronics System Division Arrangement

  Copies of the manufacturing assembly parts list as-built configuration report (MAPL-ABC) are generated and transmitted to the appropriate quality assurance personnel. Quality assurance personnel compare this and the configured item assembly list. If no discrepancies are noted, the quality assurance engineer validates the configuration report by stamping each page and notifies manufacturing. If discrepancies are found, the Configuration Management Office is notified and determines with personnel from quality assurance, engineering, and manufacturing the corrective action to be taken. Corrective action will involve:

  a) Correction to the MAPL-ABC report

  b) Correction to the CIAL

  c) Issuance of an NCMR

  d) Creation of a rework MSO to correct the deficiency in the CI.

- Mechanical Hardware Operations Arrangement

  Verification of Mechanical Hardware Operations configured items is accomplished through the use of indentured assembly lists produced by Mechanical Hardware Operations from manufacturing shop orders and parts assembly lists (PAL's) which define the as-built data and compare it with the current design requirements derived by Mechanical Hardware Operations from released drawings and engineering orders. Prior to final manufacturing buy-off, two copies of the indentured assembly list are sent to quality assurance. Quality assurance personnel inspect and compare the indentured assembly list to the latest configured item assembly list. Mechanical Hardware Operations is notified of apparent discrepancies, if any, and corrective action is taken in the same manner as in the Electronics Systems Division arrangement.

- Space Technology Division Arrangement

  The revision levels of actual parts installed in Space Technology Division configured items are entered on an assembly inspection and installation log (AIIL) and verified by quality assurance personnel at the time of installation. Prior to final manufacturing buy-off, the quality assurance engineer compares the log to the configured item assembly list and stamps the log off to signify validity of as-built configuration. Any corrective action necessary is taken in the same manner as in the Electronics Systems Division and Mechanical Hardware Operations arrangement. A copy of the final configuration report, the final indentured assembly list report, and the final assembly inspection and installation log report accompanies the configured items to the integration and test phase. In addition, the Configuration Management Office retains one copy of each report in a project master file.

3.10.3 Configuration Verification

Verification is effective only on the configured items that are processed through the manufacturing phase. Configured items that were produced under the OGO contract and are used on ERTS are not subject to reverifications.

3.10.4 Computer Program Configured Item (CPCI) Configuration Verification

Verification of CPCI's is achieved through functional demonstration testing of the software definition (as specified in the CPCI specifications) to the performance requirements as stated in the acceptance and test specification.

The acceptance and test specification has three purposes:

- To specify the purpose, goals, and requirements and describe the testing during software development to ensure that adequate systematic testing is being performed at each program structure level of testing

- To provide a set of formally stated test requirements, tests, and acceptance criteria for module, function, and overall subsystem testing to be used by the contractor in preparing for and conducting final government acceptance.

- To identify the final software acceptance demonstration tests to be run against the integrated software under realistic operating conditions.

The acceptance and test specification is used to plan and conduct testing of the software and provides a basis for analysis of the test output and acceptability of the software product. The specification includes at least the following:

a) General

This section describes the scope, content, organization, intended use of the document, and reviews the test management, personnel, and procedures governing all phases of development, validation, and acceptance demonstration testing. The computer program structure and the application of the testing to that structure are discussed. The overall test approach is presented from the standpoint of levels of testing. Under levels of testing, routine testing, module testing, function testing, subsystem testing, and final software acceptance testing are discussed. The discussion of tests includes both positive and negative aspects of testing and considers both the tasks and appropriate actions required as a result of the tests.

b) Test Program Control

This section details the control and reporting procedures employed throughout the test program. A rigid accounting system for the control and revision of acceptance and test specification (validation and operational demonstration tests), test case data, auxiliary master tape, test reporting, problem reporting, and retesting procedures (in case of test failure) is developed.

c) Testing Levels

1) Development Testing

For each of the software levels to be tested (routine, module, function) a set of unique characteristics or capabilities is listed which are to be checked. Associated with each test is a concise description of the test. Redundant testing of capabilities at different levels is minimized (e. g., an equation tested at the component level need not be rechecked at the function level). Testing at this level is left to the discretion of the individual programmer or engineer responsible for the routine, module, or function. There is little formal control of test objectives, test procedures, input-output, and test discrepancies at this level.

2) Validation and Acceptance Testing

Test requirements and validation tests are developed and applied by a formal product assurance group against the software performance and design requirements specified in the contract baseline. These requirements are tested thoroughly at one or more of the following software levels: module, function, or subsystem. These tests include possible abnormal situations to which the software can be subjected and from which a predetermined response can be expected. Redundant testing of requirements at different levels is minimized.

Acceptance tests are developed and performed to verify all performance and design requirements. The preliminary version of this document contains, as a minimum, baseline requirements and examples of test requirements and test procedures. Acceptance tests will be a selected subset of tests performed during the validation phase. Final test requirements fully explained in terms of software levels, test methods, and acceptance criteria, applicable to the baseline requirements are furnished at critical software review. Final test procedures are provided in the final version of the acceptance and test specification that is a part of Milestone D of the ERTS development milestone plan.

At this testing level, formal procedures are implemented to control the development of test procedures and software configuration management (including reporting and resolution of software discrepancies), test execution, test data retention, and test result reporting.

4. CONFIGURATION CONTROL

4.1 INFORMAL AND FORMAL CONTROL

A system of informal and formal change control in compliance with NASA GMI 8040.1 will commence upon contract go-ahead and will be effective on configured items and computer program configured items throughout the life cycle of the items for the duration of the contract. The Stage 1 configured article list (paragraph 2) identifies those items that are subject to the informal requirements; Stage 2 and 2A lists identify the items that are under the formal requirements.

4.1.1 Informal Change Control

Change control effective on Stage 1 baselined configured items and computer program configured items requires a Configuration Management Office review of the applicable design documentation referenced below to ensure that all changes are included and that the documents define the actual configuration of the configured items or computer program configured items.

- Engineering drawings
- Engineering orders
- All applicable specifications
- All manufacturing and software fabrication and development procedures
- Interface control documentation

The Configuration Management Office review will result in a perpetually current Stage 1 configured article list that enables the configuration to be determined at all times. As configured items and computer program configured items progress through critical design review and the design is released, the configuration freeze data will be established and the configured item and computer program configured items will be identified on the Stage 2 configured article list and as such will be subject to rigid and formal change control.

4.1.1.1 Software (CPCI) Baselines and Events

A baseline provides for formal or informal configuration control in compliance with GMI 8040.1 as approved by GSFC. Each baseline is established by approval of baseline documents and the specific program configuration. Informal configuration control begins with the design baseline. This design baseline is updated by events which occur during the development phase, leading eventually to the product baseline and operational baseline (formal configuration control).

An event is an intermediate review of the software documentation or software products to update the baseline requirements for the design process but does not establish new baselines. Examples of events are the critical software reviews and the final software design (Milestone D) documents (see ERTS development plan). Completion of an event starts contractor-internal control that precludes major changes to either the approved design or documentation without written notice to GSFC.

Design Baseline (Informal stage 1 control)

The design baseline is based on the computer program design criteria (Milestone A), the implementation concepts and preliminary design specification (Milestone B), and the computer program interface specification (Milestone C). All changes to the design baseline must be approved by GSFC through the authority of the local representative.

Product Baseline (Stage 2 formal control)

The product baseline is based on the design baseline and events which occur during the development phase and the computer programs accepted at delivery as well as approval of the computer program products and documentation (Milestone E). The product baseline includes the software products and supporting documentation, principally the updated Milestone D. All Milestone E tests must be completed and all other Milestone E event products must be accepted by GSFC before the product baseline is established.

Operational Baseline (Stage 2 formal control)

Successful completion of the operational demonstration test following system integration establishes the operational baseline. The software system is formally delivered to GSFC at this time. The operational baseline includes the integrated software system, the updated Milestone E and Milestone F, and the associated computer program listings, decks, and tapes.

Multiple Baselines

There can be more than one version of deliverable computer programs, which can be controlled simultaneously. New or changing system requirements often lead to extensive modifications to the software. Under these conditions, informal and formal stage 1 and stage 2 baselines can coexist.

Each baseline is identified and controlled separately and simultaneously. Identification is through submission of a configured article list and a delivery letter whenever a new or updated baseline is released by the contractor. All changes from the previous baseline are identified and documented before the new baseline is installed in the software system. Computer program listings must be provided and identified whenever programs are recompiled. If modifications via correctors are being delivered, reference to the pertinent software modification record is required to describe the exact computer program configuration.

4.1.2 Formal Change Control

Formal change control is effective on all configured items identified on the Stage 2 and 2A configured article lists; they are subject to varying degrees of the formal system as specified in paragraph 2. Configuration control will extend over the entire service life of a configured item or computer program configured item. Configuration changes of all these items and their related documentation will be processed in accordance with this plan. Configuration changes of computer program configured items will be processed in accordance with their state-of-development as defined by the software development milestone plan that is defined as paragraph 4.2 of this configuration management plan and will be detailed in the final proposal revision of this plan.

The plan describes the delivery to NASA of six sets of documents that are essential for the preparation of operational software for the ground data handling system. These documents are called development milestones. The milestones apply to all agencies undertaking computer program efforts for the GDHS, and to both the development of new computer programs and modifications to existing programs.

The objectives of the sets of milestone documents are to provide:

- GDHS management control of conception, design, implementation, and validation of software component programs through review, comment, coordination, modification, and approval
- Timely documentation of computer program specifications, program contents, and performance criteria, at appropriate points during the development cycle for effective coordination of contributors
- Documentation of the source for complete description of all facets of program conception, requirements, mathematical development or application, implementation concepts, design specifications, and performance
- Documentation which provides NASA the means to operate, modify, amend, and integrate the ERTS software products without the assistance of the software originator
- Documentation which facilitates design and debugging at all levels.

The six sets of milestone documents are listed below, with the responsible contractors and applicable change control descriptions.

Event	Description	Control
Milestone A	Automatic Data Processing Software (ADPS) Computer Design Criteria	Stage 1 (informal)
Milestone B	Implementation Concepts and Preliminary Design Specification (computer program development contractor)	Stage 1 (informal)
Milestone C	ADPS Computer Program Interface Specification (software subsystem integration contractor)	Stage 1 (informal_

Event	Description	Control
Milestone D	ADPS Detailed Specification (computer program developer	Stage 2 (formal)
Milestone E	ADPS Computer Program Products and Documentation (computer program developer)	Stage 2 (formal)
Milestone F	ADPS Final Software Acceptance Demonstration (software subsystem integrator)	Stage 2 (formal)

Requests for changes to released engineering data will be documented by the requester by means of an engineering change request (ECR).

Customer originated formal change requests will be directed to the Project Office Contract Administrator. The contract administrator will prepare an engineering change request and submit it to the Configuration Management Office. On the other hand, subcontractor originated formal change requests by subcontractors will be directed to the ERTS subcontractor representative in accordance with Section 5. The engineering change request will be submitted to the Configuration Management Office for subsequent processing.

4.1.2.1 Analyses and Evaluation

Upon receipt of a change request, the change evaluation and control board chairman will recommend the change classification per the following criteria.

- Class 1 changes are changes to the engineering design that affect form, fit, and function so as to cause the superseded design configuration to be no longer interchangeable with the superseding design configuration; and/or contract price is affected to the extent that the contract fee of TRW Systems Group and/or the subcontractor is affected. Class 1 changes are submitted to NASA/GSFC in the form of an engineering change proposal (ECP) and are approved by the issuance of a contract change notice (CCN).

- Class 2 changes are changes that do not fall into the category of Class 1.

4.1.2.2 Class I Change Analysis

Engineering change requests classified as Class I will normally require a detailed engineering analysis and evaluation, including the gathering of cost, schedule, and relevant engineering information, the listing of all affected documents, and other pertinent data relating to the effect of the change on the released engineering design. The subproject managers will be responsible for collecting the necessary information from all affected engineering areas and will forward the completed engineering change analysis (ECA's) packages to the Configuration Management Office. The Configuration Management Office will generate the preliminary draft of the engineering change proposal and forward the engineering change request/engineering change analysis/ engineering change proposal package to each change evaluation and control board (CECB) members for analysis. The board chairman will convene the board, consistent with the urgency of the change. Its members will present their analysis to the chairman for final distribution.

4.1.2.3 Class II Change Analysis

Class II changes will not normally require an analysis by the subproject managers except for those Class II changes which are more complex or require planning and schedule commitments to assure timely incorporation of the changes. A documented change request approved by the subproject manager and the control board chairman and/or engineering orders approved by the Configuration Management Office will suffice for these changes.

4.1.2.4 Class I Change Approval

Every Class I change is presented to the Change Evaluation and Control Board by the Configuration Management Office along with supporting data, engineering change analyses, and a preliminary draft engineering change proposal sufficient to provide an adequate basis for consideration by the board. Normally the engineer most closely associated with the proposed change will be present to clarify any areas of uncertainty and answer the board's questions. Other affected personnel may be requested to attend by the board chairman. After due consideration by the board, the final decision to accept or reject the change is made.

If a change is accepted by the Change Evaluation and Control Board, the proposal will be finalized and approved by project management. The total change package is then transmitted to the contracts office and submitted to GSFC for approval.

4.1.2.5 Class I Change Implementation

Upon the receipt of a contract change notice from NASA/GSFC, a project work directive will be issued and the Configuration Management Office will release an engineering change directive (ECD) to all concerned parties. Both directives will authorize the generation and formal release of the affected design documentation for actual change incorporation.

4.1.2.6 Class II Change Approval and Implementation

Approval and implementation of change will be in accordance with one of the following methods.

- The appropriate subproject manager or his designee prepares the engineering order vellum without preparing an engineering change request. Upon completion of design and drafting check, the engineering order is routed for approval through the Configuration Management Office. Once signed by the subproject manager and the Configuration Management Office, the engineering order may be expedited to CADM for immediate release; however, a copy of the engineering order will be routed in parallel with the original through the approval cycle. Members of the approval cycle have the prerogative of notifying the control board chairman if corrective action to the engineering order is necessary.

- Where the Class II change is requested by means of an engineering change request and does not require further analysis, the chairman will directly approve the engineering change request prior to initiation of the engineering order. The engineering order or drawing will be processed in accordance with the drawing release plan.

- Where the Class II change is requested by means of an engineering change request and does require further analysis, the chairman may either approve the engineering change request for engineering order generation with engineering change directive documentation or review the engineering change request with the Change Evaluation and Control Board prior to approval decision and release.

4.1.2.7 Flow Diagrams

Figure 4-1 shows the sequence of events and the flow involved in a configuration change. Figure 4-2 shows the typical cycle through which drawing changes are processed.

4.2 SOFTWARE DEVELOPMENT MILESTONE PLAN (Figure 4-3)*

This section attempts to provide a brief description of the current software development process usually applied to software programs by TRW Systems Group. Aspects of quality assurance and test planning and integration are included to provide visibility to the overview of configuration management tasks that will be in compliance to GMI 8040.1 and are scheduled to be included in detail in the next revision of the plan. The revision will be submitted with the Complete ERTS proposal.

4.2.1 Initial Phase

The initial phase of the development is culminated in the milestone 2 design specification which once established is a Stage 1 baseline item.

4.2.1.1 Milestones

Once a milestone 2 has been established, critical design reviews for each of the routines and functions are held. As soon as approval of a critical design review package has been obtained, the coding and compilation of that routine begins. When a compilation has been made, the first step in the checkout process is begun, which is to debug that compilation and to be sure that the compilation will actually execute. See Figure 4-4 for test program sequence. In parallel with the actual coding and development, the documentation which is used to establish the testing acceptance criteria is developed. For the routine testing level, the milestone 2 and the critical design review package represent the major sources of information used to establish this criteria. The routine testing is done against this acceptance criteria and is accomplished, primarily, as an internal function of the routine development task itself. Once the routine testing has been completed and the acceptance criteria met, the next step in the testing process is testing at the function level.

*Section 4.2 of the Configuration Plan, February submittal, is now contained in Volume 3, Part II of this proposal.

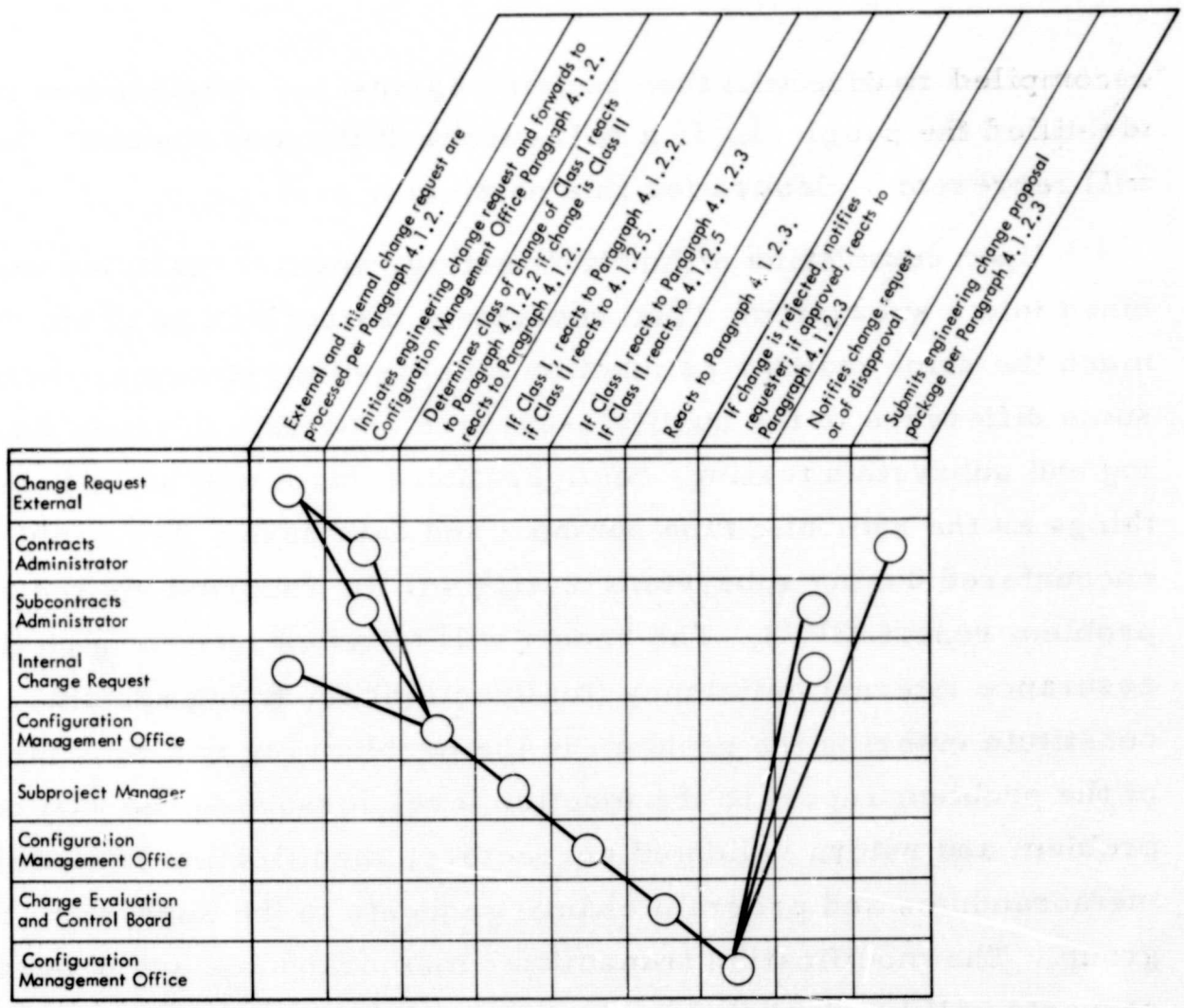


Figure 4-1

CHANGE FLOW

Function level testing is the next step in the building block system where several routines are tied together to compose a function. As was the case for the routine testing, the milestone 2 and the critical design review package are used to establish the acceptance criteria. In addition, the milestone 4 design specification, which becomes a Stage 2 baseline item, the test plan, and the acceptance and test specification, are utilized as criteria sources. Problems which are recognized during the routine and function levels of testing will be handled within the affected development task group. During the checkout of the individual routines, any problems will be corrected immediately on an informal basis. Only a slight variation of this will take place for problems encountered during functional checkout. In function level testing, any problems will be reported informally to the programmer of the affected routine for correction. Any corrections required in both routine and function testing will be made as coding changes and will require compilation of the altered routine. The

recompiled routine will then be tried against the original test which identified the problem. If it will successfully pass the test, the routine will represent a closure for this particular problem.

Upon completion of function testing, several functions will be combined into a subsystem. The subsystem testing will be performed in much the same manner as function level testing; however, there will be some difference in the quality assurance aspects. Between function testing and subsystem testing, configuration control will be initiated for such things as the symbolic tape compool and data base. Any problems encountered during subsystem testing will be reported via the software problem report (SPR). The report will be processed through the quality assurance internal deficiency (malfunction) reporting system. This will constitute entering the problem in the problem log and returning a copy of the problem report to the function level personnel who will correct the problem and return validated correctors, modification transmitter memorandums and program change requests to the subsystem testing group. The modification transmitter memorandums and program change requests will be identified against the problem report log number and notification of this will be made in the problem log.

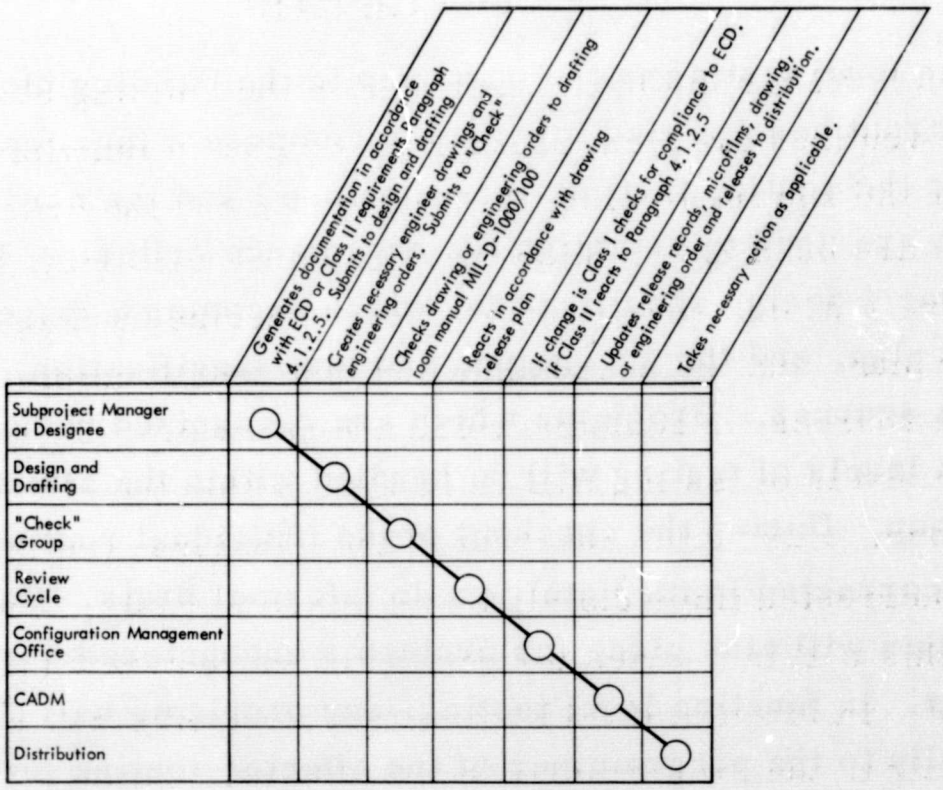


Figure 4-2

TYPICAL ENGINEERING DRAWING RELEASE CYCLE

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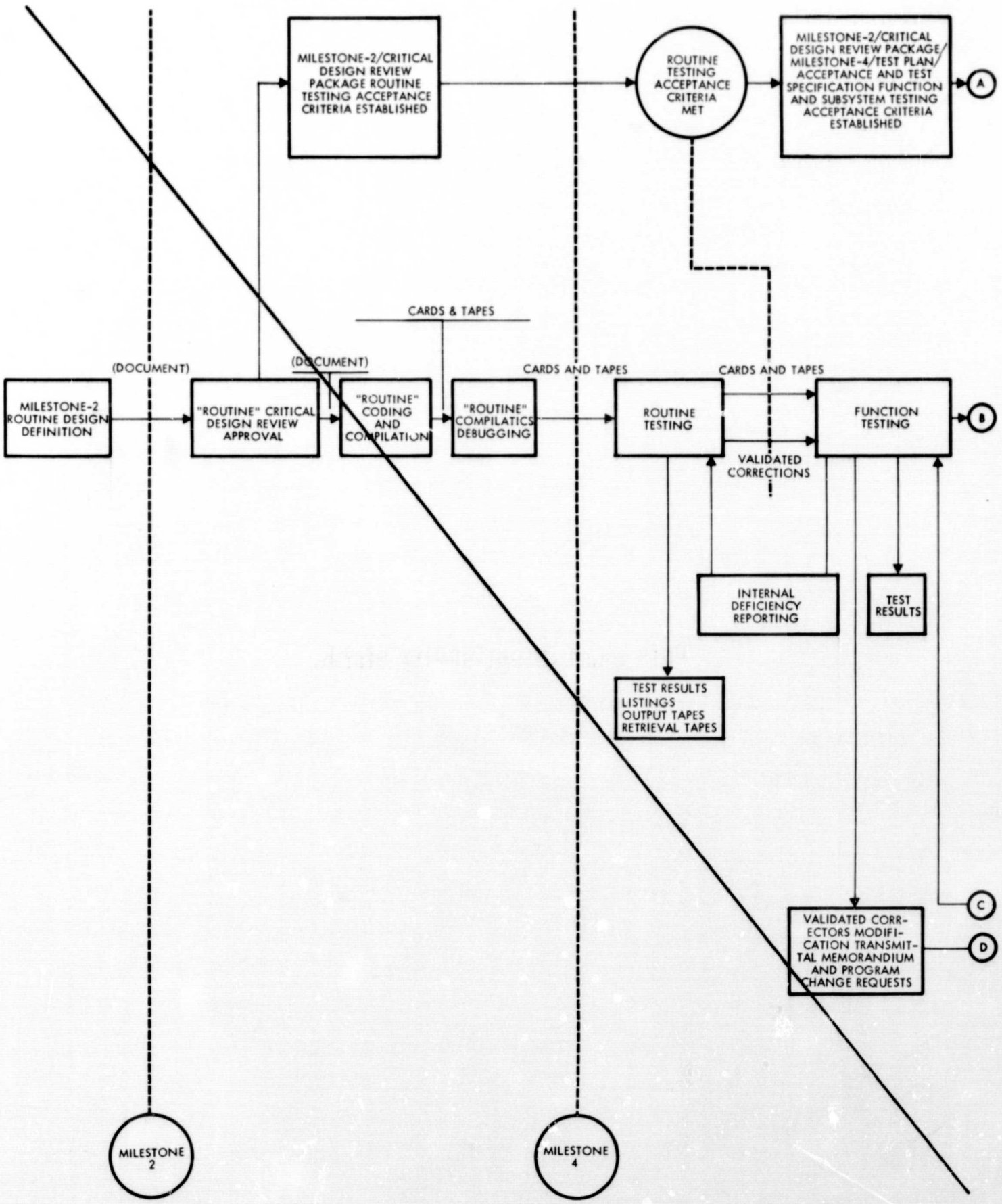

Figure 4-3
SOFTWARE DEVELOPMENT MILESTONE PLAN

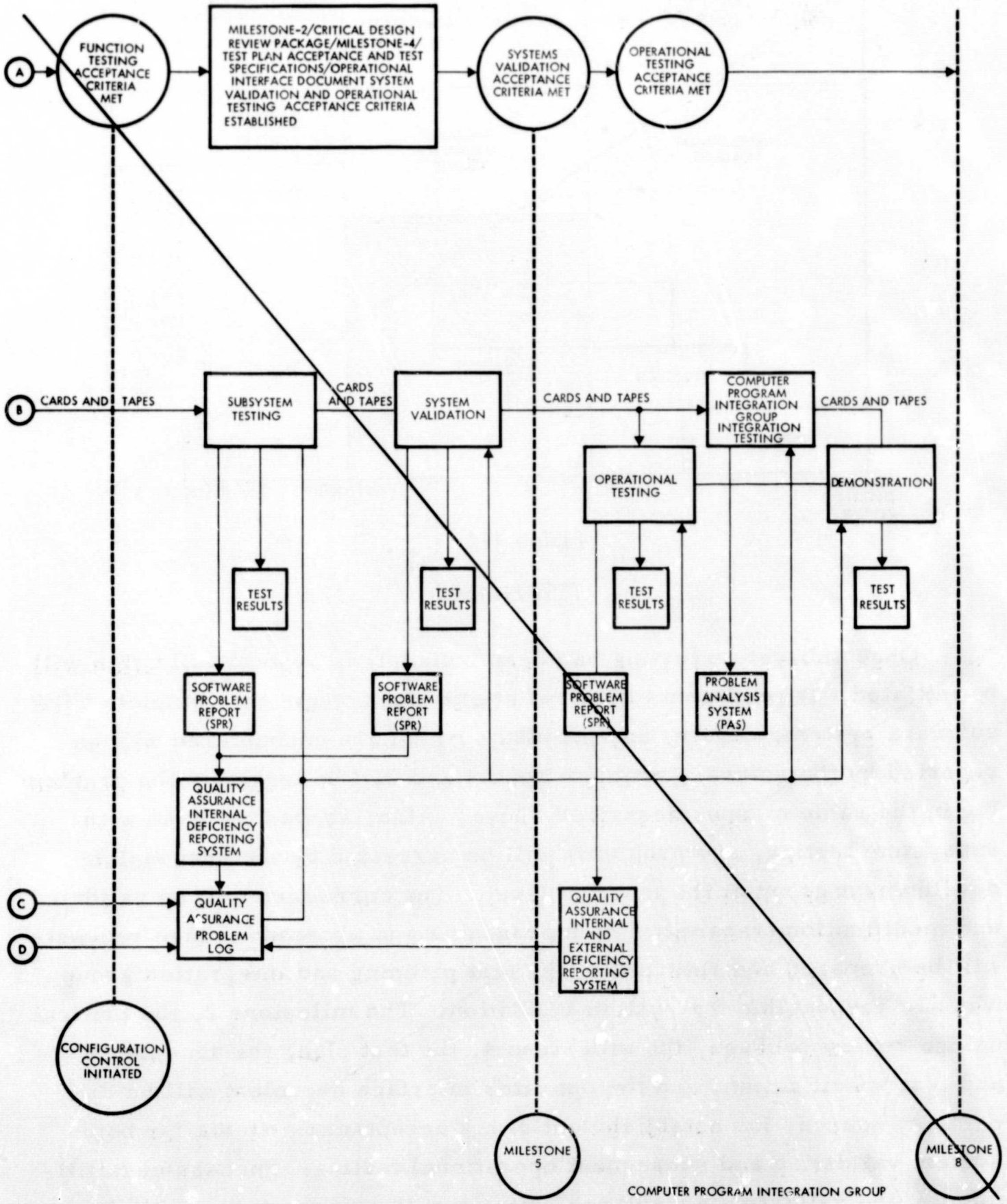

Figure 4-3
SOFTWARE DEVELOPMENT MILESTONE PLAN (Continued)

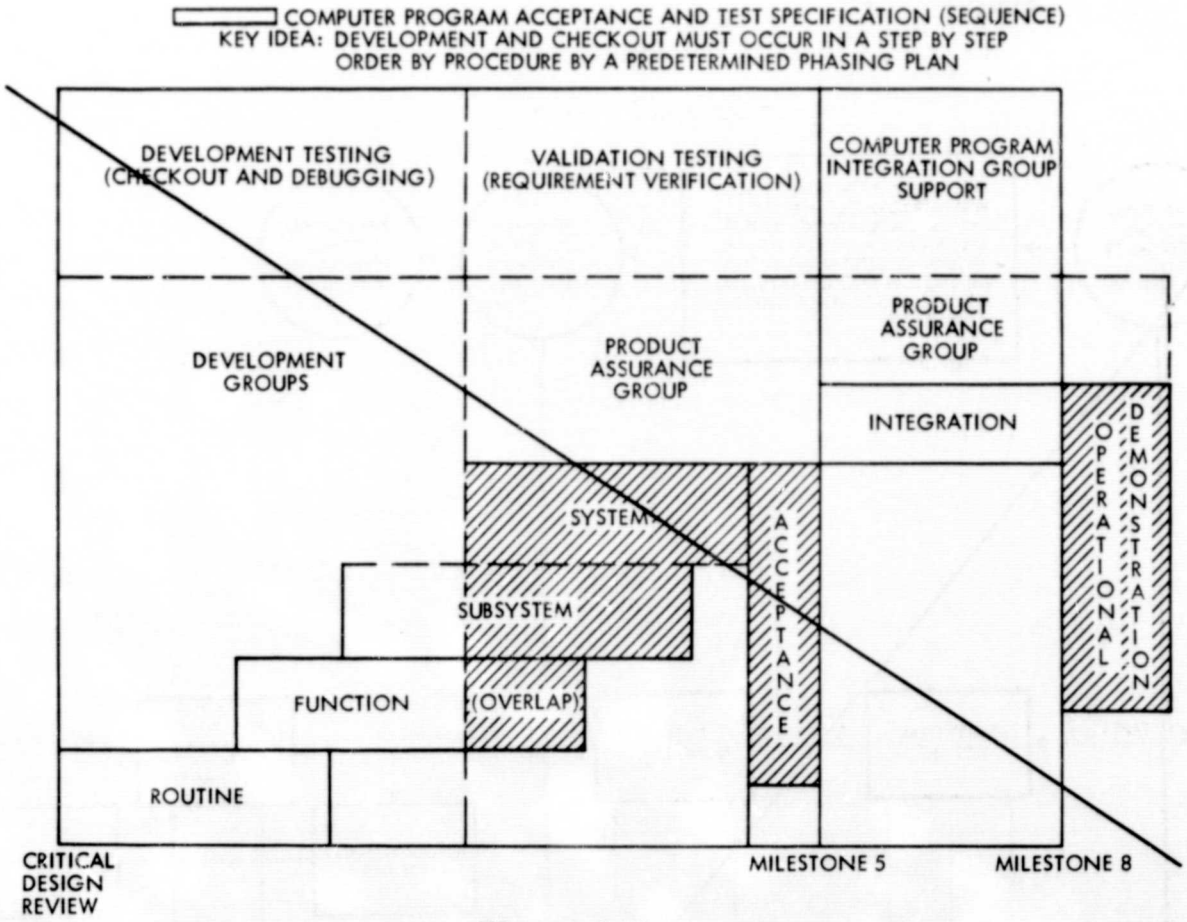

Figure 4-4

TEST PHASES

Once subsystem testing has been completed, system validation will be initiated. It represents the first attempt to execute the complete TRW software system. Again, any problems which are encountered will be reported by the software problem report and will be logged in the problem log in the same manner described above. Also, as was the case with subsystem testing, any problems will be corrected by the responsible development group at the function level. The correction will be validated, and modification transmittal memorandums and program change requests will be prepared and returned to the test planning and integration group who are responsible for system validation. The milestone 2, the critical design review package, the milestone 4, the test plan, the acceptance and test specification, and the operator interface document will be the primary sources for establishment of the acceptance criteria for both system validation and subsequent operational testing. Successful fulfillment of the validation acceptance criteria will represent accomplishment of the milestone 5. Post-milestone 5 testing will take two paths: (1) TRW's internal checkout will continue with operational level testing and (2) the

computer program integration group (CPIG) will initialize an integration testing activity. TRW's operational testing will report any problems via the software problem report. These problems will be reported both internally to development groups and externally to the customer which is a slight variation from the pre-milestone 5 reporting procedure. Any problems which are encountered by the computer integration group during his testing activity will be reported via the problem analysis sheet (PAS). The correction of such problems will be identical to the process that TRW will use internally; that is, the functional development groups will correct the problems and return the validated correctors and associated modification transmittal memorandums and program change requests to the group reporting the problem. In addition, the problem log will be maintained for all such correctors.

The final step in the TRW testing process will be the performance of a series of demonstration tests. The purpose of these tests will be to show the operational capabilities of the TRW software to the customer. This demonstration will be accomplished immediately prior to milestone 8 and will be utilized as the display of TRW's fulfillment of the milestone 8 requirements.

All test phases leading to the milestone 8 demonstration will treat the test results obtained during that particular phase in an identical manner. These test results which will be in the form of printed output, system output tapes, and data base retrieval tapes will be collected, cataloged, and stored by the data control center. Test results will be available for review by all interested parties.

4.2.? Computer Program Baseline Changes

Two types of changes to computer program baselines dependent upon their baseline status, i.e., Stage 1 or Stage 2, are distinguished by their impact on the contract with the customer or upon interfacing products. Changes to the baselines are issued on the appropriate documentation as defined by the Configuration Management Office and are reissued and distributed through CADM.

2

4.2.2.1 Class 1 Changes

Class 1 changes are those that affect any of the following:

- Contract cost or schedule
- Milestone 2 or the work statement, except for documentation corrections
- Interfacing products that must be changed to maintain compatibility at that interface
- Milestone 4 documentation after the milestone 5 event
- Computer program listing after the operational baseline is established.

Section 5 of this guideline describes how Class 1 changes are processed.

4.2.2.2 Class 2 Changes

Class 2 changes are those that do not affect any of the areas described in Section 4.2.2.1 of this guideline. Class 2 changes can be made by the contractor without prior approval from the customer. Typically, Class 2 changes are made with correctors to rectify coding errors or to eliminate software deficiencies that are detected after the operational baseline is established.

Most software development during the design baseline and preliminary baseline phases consists of Class 2 changes. Class 2 changes may or may not be reflected in the milestone 4 documentation as a function of when they are made and the extent of their effect on the design or coding.

Section 4.2.5 of this guideline describes how Class 2 changes are processed.

4.2.3 Software Change Procedures

The change procedures described in this section follow the same basic process and are separated largely by the priority attached to each change. Changes may be made according to these procedures to any of the baselines described in Section 4.2.1.1 (Pre- and post-milestone 5 change approval cycle is shown in Figures 4-5 and 4-6).

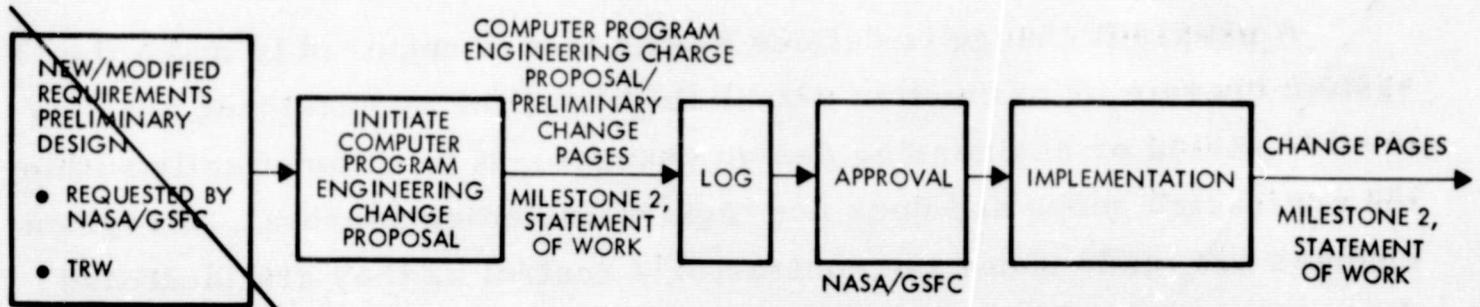

Figure 4-5

PRE-MILESTONE 5 CHANGE FLOW

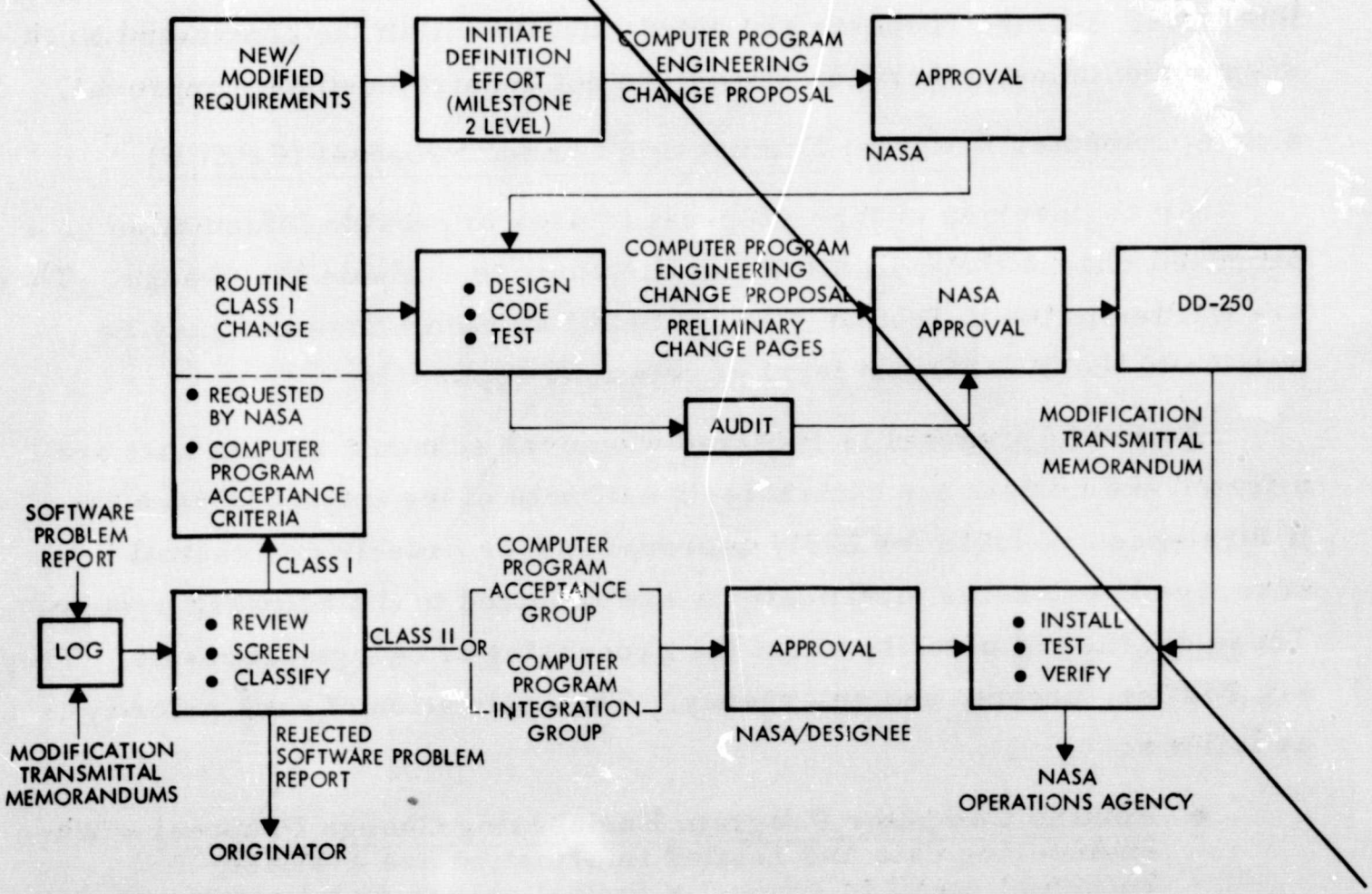

Figure 4-6

POST-MILESTONE 5 CHANGE FLOW

4.2.3.1 Program Change

A program change is defined as one that is required to make the system operate or to meet an established baseline requirement. It may involve coding or engineering design changes. It is automatically within the contracted scope and does not require customer approval. Program changes are made under the contractor's control as they are identified during the software development process.

4.2.4 Data Base Directory Change

Data base directory changes may be required (if applicable) after preliminary baseline establishment to contractor-specific data base or computer program internal communication pools. These changes are initiated with a data base directory change request (CCR) written by the contractor. They are implemented by the software integrator at scheduled intervals. Change requests are automatically within the contracted work scope, and unless otherwise stated, do not require customer approval.

4.2.5 Computer Program Engineering Change Proposal (CPECP)

An engineering change proposal is used to provide information on a proposed change that will allow the customer to evaluate the change. They are written to the milestone level of detail as a minimum and may be written to the milestone 4 level of detail, if applicable.

A change proposal is required whenever schedule and/or cost are affected and contain the contractor's estimate of the impact in each area. It furnishes a vehicle for early approval and/or orderly contractual coverage if extensive modifications are required to the software system. These degrees of priority affect the processing of change proposals. They are routine, urgent, and emergency. The application of each priority is as follows:

- Routine Computer Program Engineering Change Proposal - When engineering data and related information are available in sufficient detail to support a formal change on a normal schedule, a routine change proposal is written. The proposed change is not limited in terms of schedule or resources required and can be handled in a standard way by the configuration control staff.

- Urgent Computer Program Engineering Change Proposal - Information is available at the same level of detail as for a routine change proposal, but fast processing is required to

avoid schedule slips, to correct deficiencies that affect the software system's capability to support mission operations, or to correct interface problems that affect operational capability. An urgent change proposal is handled on an expedited basis, ahead of routine ones.

- Emergency Computer Program Engineering Change Proposal - Emergency changes to operational software installed to allow continuation of the mission are documented after the fact by an emergency change proposal. This provides the customer written notice that the change was made and presents it for customer review. Changes made to compensate for vehicle malfunctions will probably be removed when that vehicle's mission is completed. Others may be incorporated into the software system in more orderly fashion at a scheduled later date.

4.2.6 Master Tape Control

Master tapes are retained in a bonded area by quality assurance and are rigidly contracted. The tape set consists of:

- System Support Tape (SST) - This tape constains all of the system components (SYMON).

- Auxiliary Master Tape (AMT) - The tape contains program-specific data such as the computer program routines. An auxiliary compool and data base may also reside on the master tape.

- Auxiliary Data Base Tape - An auxiliary data base tape may be utilized to supplement or override elements of the data base residing on the auxiliary master tape.

Control of these master tape components will be instituted in two phases: (1) during product development, and (2) after milestone 5 delivery to the CPIG. During development, the contractor will provide notification of internal changes to the master tape configuration and maintain a historical log of such changes. Prior to the internal milestone 5 delivery, master tape control will simply consist of monitoring the configuration changes to the system support tape, since during this period several different auxiliary master tape configurations will be in existence due to the dynamic changes to the individual routines. After the internal milestone 5, a master tape configuration consisting of those elements described above will be established. A control procedure will be instituted for submission of master tape changes (similar to the modification transmittal memorandum form) issuance of the incorporation of such changes

and reporting of these changes to all affected personnel. Magnetic tapes which comprise the master tape configuration will be issued an identification number and this number will be recorded.

Subsequent to the external milestone 5, the master tape control process will primarily be a reporting function in that official modification transmittal memorandums will be required to change the computer program integration groups master tape configuration.

4.2.7 Verification

This function requires the detail analysis of the master support output runs received from the log against the delivered octal changes (MTM's) delivered to the computer program integration group. Each item on the modification transmittal memorandum is verified against the output run to assume that the total modification transmittal memorandum change was incorporated on the flight support tape character per character. When variances are found, the following action is initiated.

- A variance list for the affected block/program will be prepared.
- The variance list will note the exact variance found by the analysis.
- The affected responsible engineer will verify that the variance is in fact functionally different from the modification transmittal memorandum and will request the analysis to initiate a discrepancy report form.
- Discrepancy report forms and status reports will be initiated by the analysis.
- Copies of the discrepancy report forms will be sent to the malfunction system.
- The integration group will resubmit the updated flight support tape with the corrections noted on the discrepancy report form.
- An analysis reverifies the updated master support tape. If a variance is found, the complete cycle is started over.

4.3 CHANGE EVALUATION AND CONTROL BOARD (CECB)

4.3.1 ERTS Change Evaluation and Control Board

The board is the responsible body for reviewing and evaluating all proposed changes to Stage 2 baselined configured items and computer program contract items. The purpose of the board is to minimize pro-

posed changes to only those that are necessary to meet the ERTS project requirements and to ensure their compatibility with performance plans and schedules.

4.3.2 Chairman

The chairman is the CMO manager who in this capacity represents the ERTS project manager in all configuration control matters. In this capacity, the Configuration Management Office manager is responsible for providing meeting schedules and facilities, agendas and review material, minutes and action items, and conducting follow-up activity on final decisions concerning disposition of agenda items. A board chairman, he may also accept or reject engineering change requests and engineering change directives and provide sign-off as necessary.

The chairman is required, upon due consideration of the advice from all board members, to make a disposition to accept or to reject each proposed change. Expect in the event that additional information is needed, the chairman may table a change until he has the necessary input.

Right to appeal the chairman's decision can be exercised by any representative by submitting a written statement addressed to the project manager and sending a copy to the chairman. The parties involved will then meet and arbitrate the problem. Any reversal decision will be resubmitted to the board for corrective action.

4.3.3 Membership

The change evaluation and control board will be composed of the personnel identified in Table 4-1 who represent specific areas of responsibility. It is not intended that all members cited be present at all meetings, for an entire meeting, but they should consider themselves subject for call by the chairman as the agenda items may dictate.

4.3.3.1 Duties and Responsibilities of Members

The ERTS Configuration Management Office will furnish each member with an agenda of engineering change requests, preliminary ECP's, and/or engineering orders to be considered at each meeting. The board members are requested to review proposed changes for impact in their areas of responsibility and to appraise the chairman of their findings.

Table 4-1. Membership Roster of the ERTS Change Evaluation and Control Board

Capacity	
Chairman	Configuration manager
Change administration and planning	Configuration management office
Engineering*	Communications Antenna Attitude control Data handling Electrical power Electrical distribution Structures Thermal Propulsion GDHS-operation control center/NASA data processing facility System engineering
Manufacturing*	Electrical fabrication TLM electronic fabrication Electrical integration fabrication Software and information system division development and fabrication Space technology division fabrication Space technology division procurement Propulsion integration Mechanical hardware operations fabrication Thermal fabrication
Integration and test*	Spacecraft electrical and mechanical Integration environmental test Software integration and test
Material*	Purchasing Parts, materials, and processes Materials engineering
Performance assurance	Quality assurance, reliability, PM&P and maintainability
Contracts	Contract interpretation: negotiations
Project planning and control	PERT networks, master schedules
Finance	Pricing, budgets, cost estimates
Logistic support	Liason - All off-site activities

*Attendance of these members at each meeting based upon whether or not changes to be considered affect their individual areas of responsibility.

Where applicable, each board representative will coordinate agenda items with personnel in other divisions of TRW which are performing tasks in support of the project. If necessary, support personnel will accompany the representative to the meeting.

Agendas and review material will be distributed to representatives at least 48 hours in advance of the meeting. The review material must be coordinated with TRW support people to ensure that each representative will be prepared to provide performance, schedule, and cost commitments which are necessary to properly evaluate the total scope of the proposed change by the chairman.

4.3.4 Submittal and Review of Proposed Changes

Subsequent to the establishment of the Stage 2 baselines, all proposed changes to configured items and computer program configured items will require an engineering change request or the appropriate software change report document approved by the ERTS board prior to preparation of engineering orders and/or specification change notices (SCN's). The engineering change request will list all documents affected by a given change and every resulting engineering order or specification change notice will reference the approved change request document as an authorizing document. This reference will be verified by the Configuration Management Office prior to release of engineering orders and/or specification change notices.

4.3.5 CECB Administration

Administrative functions of the board will be performed by configuration administration and planning (CAP) personnel reporting to the chairman.

Major functions of the administration and planning is to:

a) Record all actions of the board

b) Convene and chair the change planning board described in paragraph 4.3.6

c) Follow-up implementation of changes approved by the chairman to record status and completion.

4.3.6 Change Planning Board (CPB)

A configuration administration and planning person will act as the chairmen of a three member change planning board, consisting of himself as project office representative, a manufacturing or integration planner, a performance assurance representative, and others as required. This activity

is basically responsible to the change evaluation and control board and will convene at the planning board chairman's request to provide the control board with recommended effectivities and disposition of parts or actually dictate these items through delegation of the chairman.

The duties of the change planning board are as follows:

a) To establish recommended effectivity and disposition of parts

b) Based on decisions made by the change planning board, the planning representative will be responsible for coordinating any changes to planning sheets. The performance assurance representative will be alerted to these changes in the equipment at a time prescribed by the board's planning and scheduling and will be responsible for reporting the completion of this type of activity to the board.

c) The change planning board will monitor all product improvement and record-type changes which have been accepted by the change evaluation and control board chairman. The change planning board will function as a team in planning, scheduling, and recording the incorporation of product improvement and record-type changes.

4.3.7 Software Change Planning Board (SCPB)

An additional configuration administration and planning person reporting to the change evaluation and control board chairman will act as the chairman of this board. The membership will be composed of personnel trained in the software disciplines and thoroughly familiar with the scheduling and control of software documentation as referenced in Section 4.2. The duties of this board will be similar to those of the change planning board and will be detailed in the next revision to this plan.

4.4 UNIFORM SPECIFICATION MAINTENANCE

4.4.1 ERTS Project Specifications

These specifications consist of spacecraft configured item specifications (D-xxxxx), GDHS equipment specifications (EQ-xxxxx), and software specifications (CP-xxxxx).

4.4.2 Parts, Materials, and Process (PMP)

PMP specifications are not unique to the ERTS project. They are generated by the TRW Systems Group responsible PMP groups and are universally used by many projects.

4.4.3 Release and Control

All project specifications will be processed through the ERTS Configuration Management Office and the appropriate design review board for final review and approval before CADM formal release on Stage 1 baselined items.

CADM has established procedures for maintaining release records, microfilming, and controlled distribution. The Configuration Management Office will be responsible for establishing the controlled distribution list for all project specifications. It will be documented in the project release plan. All original specifications masters will be stored and controlled by CADM.

4.4.4 Specification Change Documents

Any document which effects a change to an existing release specification is a specification change document. These include revisions, specification change notices and deviations.

4.4.4.1 Revisions

A permanent change to a specification is implemented by a reissue of all pages and supersedes the previous issue. Revision of a specification includes incorporation of all outstanding specification change notices.

4.4.4.2 Specification Change Notices

A specification change notice TRW form 1397 is a release document used to identify changes to individual pages of a specification. The notice delineates the original and revised page(s), paragraph(s), and/or wording and description which have been changed. Each page of the specification affected by a change must have a separate notice page so that it can be filed opposite the page(s) affected. Specification change notices are used for project specifications only.

4.4.4.3 Engineering Order

An engineering order TRW form 757, is used to identify and process changes to parts, material, and process specifications, and is attached to the appropriate parts, material, and process specification. After five engineering orders have been processed, the parts, material, and process specification must be updated to the next revision and incorporate all outstanding orders.

An engineering order is also used to record deviations to parts, material, and process specifications and will be filed with the appropriate parts, material, and process specification. Since a deviation is a departure from the original requirements of a specification and its effectivity is limited to a particular project, deviation engineering orders are not incorporated into the parts, material, and process specification.

4.4.4.4 Specification Deviation

A specification deviation is a departure from the original requirements of a project specification. Deviations will be recorded on specification change notices against the affected specifications. Upon approval, the deviations become a permanent part of the specification. Deviations to project specifications will require customer review and approval.

4.4.4.5 Specification Change Record

A specification change record TRW form 1393 is used to reflect the complete approved change history of the project specification, i.e., specification change notices, revisions, deviations, authorization, effectivity, dates, and pages affected and will be included directly following the title page of each project specification.

4.4.4.6 Revision Record

TRW form 1392, filed directly following the title page of each parts, material, and process specification, will reflect the complete approved change history of the specification. The record will not record deviation engineering orders.

4.4.4.7 Configuration Management Office

The ERTS Configuration Management Office will coordinate the review and approval of all specifications relative to Stage 1 and Stage 2 baseline items.

Changes or deviations which are common to more than one specification (both parts, material, and process and project) will require a change document to each specification affected. A single change document calling out application to a series of specifications will not be processed.

4.4.5 Project Specifications

The ERTS Configuration Management Office is responsible for the review and release through CADM of all revisions to project specifications and specification change notices in addition to coordinating and obtaining the necessary signatures outside of the responsible subproject area. Review of the specifications is dependent upon the baseline status of the configured item or computer program configured item. If the specification is relative to a Stage 1 baseline item, the review will only provide assurance that the change is documented. If the specification is relative to a Stage 2 baseline item the Change Evaluation and Control Board will be responsible for determining change affects and the necessary action to be taken.

Original masters will be stored by CADM. Authorized personnel may obtain the masters of a specification for change or revision from CADM by submitting an original change request form number 1833.

Specification change notices will be prepared using form 1397. A separate specification change notice page is required showing the change opposite each page affected in the specification. A revised cover sheet, specification change record form, and an engineering data release authorization shall accompany each specification change notice submitted to the Configuration Management Office.

4.4.5.1 Change Requests

Change requests to project specification may be initiated by an interested person within the project or its supporting organizations via an engineering change request or software change request. The change request is

forwarded to the software change planning board and/or the Configuration Management Office as appropriate. The software change planning board/ Configuration Management Office will react in accordance with paragraph 4.4.5 on the change request if effective on a Stage 1 baseline item and in accordance with 4.4.5.2 if the item is against a Stage 2 baseline item.

4.4.5.2 Change Requests (Stage 2 Baseline)

Requests to Stage 2 baseline items are forwarded to the Configuration Management Office who will ensure coordination with the software change planning board/change planning board and/or the responsible manager. If the change request is initiated by the responsible unit engineer or has been processed through the software change planning board/change planning board it will be submitted directly to the change evaluation and control board.

Disposition of the change request by the change evaluation and control board may fall into one of the following categories.

- Disapproval. The change request will be returned by the Configuration Management Office to the originator so noted.

- Request for Further Analysis. The change request will be returned to the Configuration Management Office which will transmit copies to all subproject managers for their inputs via engineering change analysis regarding effects on interfaces to equipment under their design responsibility. The completed engineering change analysis will be transmitted to the Configuration Management Office to be assembled as a complete package of comments for subsequent transmittal to the chairman and members, as directed by the chairman for disposition. If a subproject is not affected, the engineering change analysis should so state. A positive reply will be required.

- Approval. If the engineering change request is approved, the change evaluation and control board chairman will notify the responsible engineer to prepare the appropriate specification change document. Evidence of coordination, approval of specification change notices, and deviations will be by signatures in the coordination block on the bottom of each sheet. Coordination approval and date on specification revisions will be effected on the cover sheet. The change evaluation and control board chairman must accept the final engineering change request/specification change notice before it can be released.

4.4.6 Parts, Material, and Process (PMP) Specifications.

For these specifications under the cognizance of either the Components Department or the Materials and Processes Department, the requester will transmit an engineering change request. This transmittal will be sent to the ERTS Configuration Management Office. The change will be analyzed and, if found acceptable, will be implemented. Depending on the nature of the change and its impact on the project, the method of implementation will be defined. This could be a revision to the specification, a deviation to the specification, or a new specification. If the change cannot be accepted, the requester will be so informed and assistance provided to resolve the problem which prompted the original action. If the engineering function cognizant for the parts, material, and process specification initiates the change, this function may elect to prepare the change document without the engineering change request or materials and processes engineering change request.

Change documents for parts, materials, and process specifications are limited to revisions and deviations. Coordination of the change document will be effected by the same organizations contributing inputs to the basic specification. Final decisions concerning the disposition of coordination comments will be made by the office responsible for the specification preparation, except for deviations affecting the project which must be approved by the Change Evaluation and Control Board.

Requested changes affecting cost, interchangeability, or reliability will result in the preparation of a new specification which will be identified by a new number.

4.5 ENGINEERING DRAWINGS

This section defines the engineering drawing control system that is applicable to the ERTS project.

4.5.1 Breadboard Model Drawings

Change control will not be implemented by the Configuration Management Office.

4.5.2 Engineering Model

Control is optional and is to be defined by the appropriate subproject manager; however, drawings must be released upon completion of the engineering model fabrication.

4.5.3 Spacecraft Qualification, Life, Test, Prototype, Production and Spares Hardware, Mechanical Ground Support Equipment, and Electrical Ground Support Equipment.

The ERTS project Configuration Management Office will approve all drawings for release by signing the engineering drawing release authorization form 1402. CADM will not release any ERTS drawings without Configuration Management Office approval.

CADM has established procedures for maintaining release records. These records will contain the document number, release date, current revision status, drawing size, number of sheets, and assembly information. All drawings will be microfilmed in accordance with TRW specification PR1-2 and mounted in TRW card format. The Configuration Management Office will establish the control distribution of all drawings for individuals and organizations requiring copies for fabrication, check-out, and delivery of hardware and software. Only controlled copies of engineering data are authorized for use in fabrication, procurement, test, and inspection of hardware. All original masters will be stored and controlled by CADM.

4.5.4 Change Control

Change control on drawings released to fabrication will be by engineering order only. Engineering orders will be prepared and submitted on form 757. Three types of engineering orders will be used.

a) Change engineering order authorizing a permanent change to information covered on a released drawing

b) Limited effectivity engineering order or variance engineering order authorizing a limited effectivity change to information covered on a released drawing. (This type will be held to an absolute minimum.)

c) Drawing revised engineering order giving notice that a drawing has been revised for release.

After five change engineering orders have been accumulated against any one drawing, a drawing revision engineering order must be issued.

Engineering orders against multiple usage drawings will be coordinated by the Configuration Management Office with other users and the serial number effectivities of the other projects will be cited or the notation "Schedule by Manufacturing" will be made. If a change is made which produces a noninterchangeable configuration between the serial numbered articles used by ERTS and the other using project, a new dash number will be created and the drawing and part will be completely reidentified and reserialized under the new number.

Reidentification by dash number only will not result in reserialization. The decision as to which method will be used will be made by the change evaluation and control board chairman/Configuration Management Office.

Issuance of expedited engineering offices will be permitted for situations where their use is required to maintain production, integration, or test schedules.

Issuance of expedited engineering orders is limited to company authorized liaison engineers. All expedited orders must be concurred with by the subproject manager or his designee and the Configuration Management Office prior to initial distribution.

Designated liaison engineers will assure that expedited engineering orders contain the required configuration information and will review with the change evaluation and control board chairman all changes which may require retest or affect interfacing schedules. Copies of the expedited engineering order will be distributed to fabrication planning, quality assurance, integration planning, and the Configuration Management Office. The original vellum of the expedited engineering order will be delivered to the Configuration Management Office.

4.5.5 Spacecraft Electronic Parts Matrix

Since the parts matrix is a drawing, it will be controlled as outlined in Sections 4.5.3 and 4.5.4.

All engineering orders or revisions will be signed by the parts, materials, and process office and submitted to the Change Evaluation and Control Board for approval.

4.6 TEST PROCEDURES

This section defines the test procedure release and control system that is applicable to the ERTS project.

4.6.1 Procedure Control

The Configuration Management Office is responsible for the release of all test procedures and is the procedure control point. Authority for system level test procedures has been delegated to the manager, Spacecraft Assembly and Test.

The Configuration Management Office will maintain a visi-record for every released procedure. Each card will show the following information.

a) Number and title

b) Total number of pages

c) Approved signatures required

d) Revision status and released date

e) All engineering data request and engineering data release authorization numbers

f) All outstanding test change requests.

System level test procedure masters will be stored and controlled by the manager, Spacecraft Assembly and Test, who is responsible for issuing all test record and information copies. All other test procedure masters will be stored and controlled by the Configuration Management Office with test record copies furnished by the Configuration Management Office or CADM.

All tests will be documented on a test record copy of the test procedure, identified to a serially numbered test item.

4.6.1.1 Test Change Record (TCR)

Test change record deviations from procedures will be authorized only when accomplished in accordance with the following provisions.

When a need for a deviation becomes apparent, a change record may be issued by the test supervisor subject to the following:

1) Changes of a typographical nature. The test operator may make the change. The test supervisor is required to provide signature approval of the change.

2) Changes in test setup, test equipment configuration, or minor procedural step sequence changes which do not change test parameters, tolerances, or measurement accuracies. The test supervisor may make the change with oral approval of the subproject manager, unit engineer, or manager for integration and test responsible for preparation of the procedure. Oral coordination shall be recorded by notation on the bottom of the test change record identifying the person contacted and the date. Written approval by signature on the test change record of the manager or his alternate must be obtained prior to completion of the test data package.

3) Changes in specified test parameters which do not result in deviation from specification requirements. The test supervisor may make the change with oral approval of the subproject manager and appropriate integration and test manager. The procedures for notation of coordination and written approval that apply to item (2) apply to this change class also.

4) Changes in test parameters which fall outside the specification requirements may result in the issuance of a test change record only after written approval from the integration and test manager and sign-off by the Configuration Management Office. In addition to the issuance of a test change record, a discrepancy report (DR) or nonconforming material report (NCMR) as appropriate, will be initiated at the time of occurrence by the quality assurance inspector assigned to test the integration and test manager and the Configuration Management Office test procedure coordinator that an out-of specification situation exists. The inspector will record the discrepancy report or nonconforming material report number in the test change record reason for change block at the time the test change record is written. The discrepancy report/nonconforming material report is not answered by the test change record but requires material review board action or the issuance of a specification change notice (SCN) to the applicable equipment specification.

NOTE: In cases of changes (1) through (4), when the appropriate approvals are recorded, the test may continue. Conduct and witnessing of the test shall be accomplished using the master test change record. The quality assurance inspector certifies by his stamp and signature that all testing has been performed per the procedure and test change record.

5) Test change records may be issued only when time does not permit a procedure change order or revision to the procedure, i.e., immediately prior to or during test. Test change records apply only to a single serial numbered item under test. If the variation is to be made a permanent part of the test procedure, before further testing, a procedure change order must be generated or a revision must be made to the procedure.

6) A test change record will be considered authorized for use during a test operation when signed by the responsible test supervisor. It is the responsibility of the test supervisor to obtain the oral or written approvals required for the type of change involved as defined in 1 through 4 above.

The quality assurance inspector will:

1) Confirm the proper authorization of the test change record by consulting with the program test change record authorization list as established by the project manager.

2) Attach a copy of the test change record to the test record copy of the procedure for incorporation into the test data package.

3) Only accept units after satisfactory completion of tests in accordance with the procedure and applicable test change records for the serial numbered item involved.

The Configuration Management Office will receive copies of all test change records and will obtain change evaluation and control board review and suspense them to ensure that the required procedure change order or revision to the test procedure are generated to close them out.

All test change records must be reviewed by the Configuration Management Office. As part of the review, the Configuration Management Office will determine whether or not to incorporate the test change record and if the change exceeds specification requirements, the Configuration Management Office will initiate an engineering change directive to revise the affected specification.

4.6.1.2 Procedure Change Order

A procedure change order constitutes a permanent revision to a test procedure in that it is valid for an indefinite number of test items. As a general rule, when the number of orders exceeds 10 percent of the total pages or a quantity of five pages (whichever is greater), the master copies should be revised.

Implementation of the procedure change order shall be as follows:

a) When a permanent change to a test procedure is found to be needed, but the magnitude of the change is such that revision (and reissue) of the master copy is unreasonable, a procedure change order may be prepared by the test engineer/test conductor, test manager, unit engineer or responsible subproject manager.

b) The procedure change order will be identified by a revision alpha-numeric system as follows:

   1) For a "no-change" version of the procedure: A1, A2, etc.

   2) For an "A" revision of the procedure: B1, B2, etc.

   3) For a "B" revision of the procedure: C1, C2, etc.

c) The procedure change order will carry the same approval signatures as the master copies of the test procedure.

d) The approved procedure change order will be forwarded to the project Configuration Management Office where it will be logged in, reviewed, and forwarded to CADM with the exception of system level test procedures for reproduction and distribution to the same list as the original test procedure. The master copy of the procedure change order will be inserted with the masters of the test procedure and a notation will be made on the record sheet by the project Configuration Management Office.

e) Each responsible subproject manager will be responsible for incorporating procedure change orders into a "Master Revision" in accordance with the policy established above. The integration and test manager will identify the required due dates for incorporation of the outstanding procedure change orders as a part of the current status reporting to subproject managers. The subsequent revision of the master will carry its own revision letter, irrespective of the number of procedure change orders incorporated.

4.6.1.3 Revisions

All revisions will be submitted to the Configuration Management Office for review and approval by the Change Evaluation and Control Board prior to release. Revision will require the same approval signatures as the original release and all outstanding test change records must be incorporated.

5. SUBCONTRACTOR CONFIGURATION MANAGEMENT*

This section defines the standard configuration management requirements for a subcontractor engaged in the design, development, fabrication and delivery of configured items or computer program configured items of equipment for use by TRW Systems Group on the ERTS Project. Data prepared as a result of the contract of which this document is a part, but not specified as a deliverable item, shall be made available to TRW Systems Group upon specific request.

5.1 APPLICABLE DOCUMENTS

The following documents of the specific issue and date shown form a part of this document to the extent specified herein. In the event of any conflicts between the requirements of this document and the listed documents, the requirements of this document shall govern.

Specifications

MIL-D-1000 1 March 1965	Drawings, Engineering and Associates Lists
MIL-STD-100 1 March 1965	Engineering Drawing Practices

NASA

GMI 8040.1 5 October 1967	NASA Goddard Space Flight Center Management Instruction

U. S. Government

H4-1 October 1967	Federal Supply Code for Manufacturers, United States and Canada

TRW

PR 1-3	Submittal of Engineering Data to TRW Systems Group by Suppliers, Print Quality, Requirements for

*When clause 67 of Systems Form 1991 (Supplier Quality Requirements attachment 1, SQI3.0.3) is required by purchase order, this section shall apply.

5.2 REQUIREMENTS

5.2.1 General

The seller shall demonstrate to TRW Systems Group the management capabilities necessary for the conduct of a configuration management program on this subcontract by permitting periodic audits by TRW Systems Group of the subcontractor's configuration management procedures for compliance with the requirements of the seller's configuration management plan.

5.2.2 Configuration Management Plan

The seller shall submit to TRW Systems Group a configuration management plan in accordance with the requirements of GMI 8040.1. This plan will describe how the seller intends to ensure proper configuration identification, control, accounting, and verification to satisfy the requirements of this contract.

The seller shall provide and maintain a configuration management system in accordance with his plan to reflect the following as a minimum:

- Establishment of required baselines in compliance to GMI 8040.1 to serve as engineering design reference points for change activity
- Formal changes, revisions, and corrections to specifications
- Procedures for identifying and interrelating contract item equipment, facilities, spares, contract documents, and engineering data which are to be formally approved or accepted by TRW Systems Group.
- Preparation and maintenance of release records in accordance with the seller's internal procedures which must be adequate to ensure proper control of his designs and changes thereto
- Preparation and processing of out of scope engineering change proposals which require TRW Systems Groups prior approval
- Formal reviews and inspections.

The seller shall have written procedures which define the systems to be used for configuration management. The seller shall remedy, at no cost to TRW Systems Group, any deficiencies in the seller's configuration management procedures which would preclude compliance with the requirements of this document.

The seller shall present any changes to the approved configuration management plan to TRW Systems Group for review prior to implementation.

5.2.3 Configuration Identification

All contract end items and subordinate items shall be accurately identified by drawings and/or specifications and inspected to ensure conformance therewith. The seller shall ensure the identification of configuration of the following elements:

- Every level of assembly down to the piece parts level on hardware and to the subroutine level on computer software
- Every deliverable item produced by the seller and formally accepted by the buyer (i.e., parts, equipment, and software, including operations manuals)
- Engineering drawings and/or specifications on hardware and computer software, as approved and formally released, shall be the source of all configuration requirements for the production of all other deliverable items and documents
- Contract and other source documents which establish a technical and management interface between the seller and his subcontractors, vendors, and suppliers.

Configuration identification shall be accomplished by using sets of numbers for the following, and no other identifying numbers shall be used:

- Specification identification numbers, both hardware and computer software
- Contract
- Serial numbers
- Drawing and part numbers
- Change identification numbers
- Code identification numbers in accordance with MIL-H4-1.

5.2.4 Drawings and Associated Lists

The seller shall prepare engineering drawings and associated lists in accordance with MIL-STD-100 and MIL-D-1000.

The seller shall assign part numbers and identify items on drawings in accordance with the requirements of MIL-STD-100, including the reidentification of noninterchangeable parts.

Drawings and associated lists prepared by the supplier for submittal to TRW Systems Group must be compatible with microfilming in accordance with TRW Systems Group PR 1-3. Drawing submittal requirements shall be as specified in the negotiated statement of work, and the TRW Systems Group configuration management plan.

5.2.5 Specifications and Test Procedures

Seller prepared specifications and test procedures shall be submitted to TRW Systems Group for approval as required in the negotiated statement of work, and in the TRW Systems Group configuration management plan.

The seller shall submit to TRW Systems Group, in accordance with Section 1.2.8 of this document, any proposed changes to specifications and test procedures which have previously been approved or released by TRW Systems Group.

5.2.6 Engineering Release

The seller shall prepare and maintain engineering release records in accordance with the seller's formats, systems, and procedures, subject to the requirements of Section 1.2.2 of this document.

5.2.7 Configuration Control

The seller shall control configuration in accordance with the seller's configuration management plan and procedures as approved by TRW Systems Group. Engineering changes shall be classified as Class I (requiring TRW Systems Group's prior approval) or Class II, in accordance with supplier's and TRW Systems Group's configuration management plans.

5.2.7.1 Configuration Control Prior to Configuration Freeze

The seller shall not implement any change in contract scope, or a deviation from a specification released or approved by TRW Systems Group, without prior review and concurrency by TRW Systems Group.

These changes, although not Class I, shall be submitted as Class I changes per the above referenced configuration management plans.

The seller shall maintain a record of all Class I engineering changes and effectivities.

5.2.7.2 Configuration Control Subsequent to Configuration Freeze

Class I changes after configuration freeze affecting specifications, test procedures, computer software, drawings, and associated lists require prior formal approval of TRW Systems Group before seller implementation.

After successful first article configuration audit, all changes other than Class I shall be submitted to TRW Systems Group or the TRW Systems Group resident representative for formal review concurrent with the seller's release of the documentation for incorporation of the change.

5.2.8 Seller Requested Engineering Changes

The seller shall describe each proposed Class I change in an engineering change proposal. The completed engineering change proposal, with adequate backup data, shall be submitted to TRW Systems Group for review and approval. If the change affects an approved part of a specification, the engineering change proposal shall be accompanied by a proposed specification change notice prepared in accordance with the above referenced configuration management plans.

A change which is initiated by the seller as Class II and subsequently disallowed by TRW Systems Group as Class II shall be cancelled. The seller may reprocess the change as a Class I change.

The seller shall not allow a vendor to change the approved configuration of a vendor-designed repairable item where such a change would be initially effective on any unit subsequent to the delivery of the first unit, without first obtaining TRW approval. Any request for such a change shall be processed as a Class I change.

Changes requiring prior TRW Systems Group approval are authorized only by an official purchase order change notice. If the change is not authorized, TRW Systems Group will return the proposed change to the seller with appropriate direction.

5.2.9 Baseline Concept

Configuration control will be divided into two distinct stages separated by a configuration freeze date. The configuration at the time of the freeze will constitute the baseline from which the formal procedures of configuration control will be implemented.

In Stage 1, the seller shall establish and maintain sufficient configuration control procedures to ensure that all engineering changes occurring during this stage are included in the drawings, specifications, and interface control documents that shall govern the production and definition of contract configured item. These procedures shall be used at least down to the black box level for hardware and subroutine level for software. Configuration control procedures shall result in a configured article list which shall permit TRW Systems Group to determine the configuration at any time.

The configuration freeze date will be established by TRW Systems Group and will mark the end of Stage 1. There shall be a detailed configured article list at this time, which, in effect, will indicate that the majority of the design and development work has been completed and that a configuration baseline has been established within the scope of contract definition. It is anticipated that formal procedures will not start prior to successful completion of final design review.

In Stage 2, the system of formal configuration control shall function to ensure rigid control of the configuration. The configured article list shall be maintained current by the seller in enough detail to firmly establish and identify the current configuration of all end-items.

5.2.10 Release of Engineering Changes

The seller's engineering design documentation incorporating each approved Class I change shall be completely released by the seller prior to delivery of the first unit in which the change is to be incorporated. The seller's release records shall be capable, for the duration of the contract, of describing the authorized as-designed configuration of any delivered unit.

5.2.11 Configuration Accounting

The seller's configuration accounting system must be capable of maintaining and verifying configuration status of all products for which the seller has design responsibility.

5.2.12 Configuration Verification

The seller shall certify on the acceptance documentation by a written quality assurance signature that the articles being delivered conform to the approved configuration and specification requirements.

5.2.13 Control of Subcontracted and Vendor Items

The seller shall ensure compliance with this document by his subcontractors, vendors, and suppliers to the same degree that would be required if the seller were to design, develop, and produce the procured items.

5.3 CONFIGURATION MANAGEMENT DOCUMENTATION

The supplier shall prepare and submit to the TRW Systems group buyer deliverable documentation in the format required and as specified below:

Title	Paragraph	Initial Subcontract	Revisions	Copies	Type
Configuration Management Plan	1.2.2	30 days ARO	As required	5	1 reproducible and 4 hard copies
Drawings and associated lists	1.2.4	As required by design review schedule and the TRW configuration management plan	-	-	1 reproducible and 4 hard copies
Configured article lists	1.2.8	30 days ARO as required			1 reproducible and 4 hard copies

Title	Paragraph	Initial Subcontract	Revisions	Copies	Type
Engineering change requests	1.2.8	As required		5	1 reproducible and 4 hard copies
Specifications	1.2.5	30 days ARO	As required	5	1 reproducible and 4 hard copies
Test procedure	1.2.5	30 days prior to usage	As required	5	1 reproducible and 4 hard copies

6. DETAILED PROCEDURES

6.1 ENGINEERING CHANGE REQUEST (ECR)

6.1.1 Purpose

This procedure defines how engineering change requests will be prepared, coordinated, and approved for the ERTS Project.

6.1.2 Scope

This procedure is applicable to engineering change requests submitted against ERTS Project hardware from any source. The procedure for requesting changes to multiple project usage hardware is also included.

6.1.3 Procedures

6.1.3.1 Use of Engineering Change Requests

Subsequent to the final design review of each configured item, as applicable, its approved engineering documentation is released through Configuration and Data Management (CADM) and constitutes the production baseline. Because of the impact on manufacturing planning and fabrication, procurement, and other considerations, proposed changes must receive an adequate review and evaluation before the change is implemented. This review is accomplished using the Engineering Change Request, TRW Systems Group Form 780 (Figure 6-1). An ECR may be originated by anyone desiring a change to project hardware or engineering documentation, but it must be accepted by the Project Change Evaluation and Control Board (CECB) in order to be implemented. Minor changes such as corrections to or clarification of drawings may be accomplished by direct release of an engineering order by the responsible engineer through the Configuration Management Office or through the use of an expedited engineering order by a liaison engineer.

Each ECR describes one change which may affect one or many released drawings, specifications, test procedures, and other related documentation. Thus, an accepted ECR may initiate a number of engineering orders, specification change notices, test change notices, revised purchase requests, purchase orders and other documents all related to

☐ PRIME ☐ USED ON

	DATE	ECR NO.	PROGRAM	PROGRAM SEQ. NO.	CONFIGURED ITEM	CHANGE SEQ. NO.
	REVISION		CONFIGURED ITEM ECR NO.			
TRW SYSTEMS TRW INC. ONE SPACE PARK REDONDO BEACH, CALIFORNIA — CODE IDENT. NO. 11982	SHEET OF			USED ON ECR NO.(S)		

ITEM AFFECTED	PART NO. _____ PART NAME _____ NEXT ASSEMBLY PART NO. _____	CONFIGURED ITEM	PART NO. _____ PART NAME. _____

REASON FOR CHANGE

REQUESTED BY ☐ TRW SYSTEMS ☐ CUSTOMER ☐ SUPPLIER

DESCRIPTION OF REQUESTED CHANGE: (INCLUDE SKETCH AS NECESSARY)

PRIORITY: ☐ COMPATIBILITY ☐ IMMEDIATE ☐ URGENT ☐ ROUTINE

ORIGINATOR	CCC	DATE	APPROVED BY:	CCC	DATE

REMARKS: (AREA BELOW THIS LINE TO BE FILLED IN BY COGNIZANT UNIT/RESP. ENGINEER)

EFFECTIVITY:
SER. NO. _____ THRU. SER. NO. _____

☐ MANDATORY ☐ RECOMMENDED
☐ PRODUCTION ☐ REWORK ☐ RETROFIT

CIA INFORMATION	INTERFACE:	INTEGRATION:	CHANGE CLASSIFICATION:	DISPOSITION: ☐ ACCEPTED ☐ REJECTED
DATE RECEIVED: _____ COMPLETE ACTION BY: _____ RELATED ECR'S:	☐ AFFECTED ☐ ☐ NOT AFFECTED: ☐		☐ CLASS I ☐ CLASS II	UNIT ENGINEER CCC DATE RESPONSIBLE ENGINEER CCC DATE PROJECT OFFICE CCC DATE

ENGINEERING ACTION:
ECA BY _____
EO(S) BY _____

SYSTEMS 780 REV. 10-65

Figure 6-1

ENGINEERING CHANGE REQUEST FORM

a specific change. Each of these documents must reference its initiating ECR, thereby enabling each change to be packaged under one master change number. In addition to engineering documentation, a change which exceeds or changes the scope of a work package or of the project requirements will also result in changes to program control documents (i.e., contract change proposals, project work authorizations, etc.) that must be considered before accepting a change.

6.1.3.2 Changes to Multiple Usage Hardware

Multiple usage hardware is defined as hardware which, while it may have been initially developed by one project, is now used by two or more projects. This type of hardware is usually at the configured item level.

An ECR to change a multiple usage item must be reviewed by all using projects. This review will be made concurrently using the "prime/used on" system described in the CMP 5.2 and CMI 5.1. If all affected projects accept or all reject the ECR, it is accepted or rejected accordingly. However, should one or more projects desire the proposed change, and one or more reject it, the change must be implemented only in the hardware of the accepting projects. This is done by the use of a limited effectivity engineering order(s) citing appropriate configuration identity by dash number and serial number, or by making a "CB" (Charles Bruning Process-wash off) of the drawing(s) and assigning a new part number(s).

It is necessary that serial numbers of these items be assigned by CADM in mutually exclusive blocks between projects.

6.1.3.3 Preparation of the ECR

ECR's for the ERTS Project will be prepared in accordance with standard instructions contained in CMI 5.1 as augmented by the additional instructions shown below.

1) Date. Originator shall enter date of original request or revised request.

2) Revision. The Configuration Management Office after processing shall assign revision letter to identify all changes to ECR's.

3) ECR No. The Configuration Management Office shall identify all ECR's in accordance with CMP 5.2.

NOTE: If the ECR is against a multi-usage item, the Configuration Management Office will assign a Project master charge number and forward the ECR to CADM for assignment of used-on numbers of other affected projects.

4) Item Affected. The originator shall identify the item part number, name, revision status of drawing used to prepare request, and using assembly part number (if known). If more than one part is to receive the change, attach an Engineering Change Supplement Sheet, Form 782, listing other affected parts. Note that a change is made to a part only and not to schematics, wire lists, etc., which are reference drawings and should be so listed under "description of change" if affected.

5) Configured Item. Originator shall identify configured item part number and name (if known). If the change affects more than one item, attach Form 782, listing other affected configured items.

6) Reason for Change. Originator shall state the reason for the change in sufficient detail to:

(a) Indicate what could happen if the change were not made

(b) Cite any written or verbal technical direction or other authorizing documentation for the change

(c) Justify cost savings if applicable

(d) Provide necessary background for historical purposes.

If additional space is needed, attach Engineering Change Supplement, Systems Form 782.

7) Requested by. Originator shall check appropriate block

8) Description of Requested Change. Originator shall completely describe change requested. If additional space is required, the Engineering Change Supplement (TRW Form 782) shall be used (see Figure 6-2). All known documents affected (e.g., specifications, test procedures, related drawings) should be noted.

9) Priority. Originator shall check appropriate block in accordance with instructions in CMP 5.9.

		DATE	EC__ NO.	PROGRAM	PROGRAM SEQ. NO.	CONFIGURED ITEM	CHANGE SEQ. NO.
		REVISION					
TRW SYSTEMS GROUP ONE SPACE PARK • REDONDO BEACH, CALIFORNIA	CODE IDENT. NO. 11982	SHEET OF	CONFIGURED ITEM	PART NO. PART NAME			

SYSTEMS 782 REV. 7-67

Figure 6-2

ENGINEERING CHANGE SUPPLEMENT SHEET FORM

10) Originator. The originator shall sign the ECR.

11) Approved by. The originator shall obtain approvals and endorsements required by his organization.

12) Remarks. The unit engineer and work package manager shall address remarks to the Configuration Management Office/ Change Evaluation and Control Board clearly defining the action to be taken. Prior to production baseline the work package manager's acceptance is sufficient for the project Configuration Management Office to authorize the change. After production baseline the work package manager's acceptance is a recommendation to the CECB. In addition to accepting or rejecting an ECR, the decision may be to request more thorough analysis of the total change using the engineering change analysis.

13) Effectivity. The cognizant work unit/package manager shall show recommended effectivity of approved changes. The final effectivity will be established by the Change Planning Board and approved by the CECB.

14) Change Category. The cognizant work unit/package manager shall check appropriate block.

15) Change Effect. The cognizant work unit/package manager shall check appropriate block.

16) Configuration Identification and Accounting Information. The Configuration Management Office shall complete this section.

17) Interface/Integration. The cognizant work unit/package manager shall check appropriate blocks. If "affected" block for interface is checked, an Engineering Change Analysis is mandatory. If "affected" block for integration is checked, issuance of an Engineering Change Directive by Project CECB Chairman (Procedure CMP 5.5) is mandatory.

18) Change Classifications. Leave this block blank.

19) Disposition. Subsequent to the product baseline this block will be completed by the CECB Chairman.

20) Engineering Action. When an ECR is accepted, the Configuration Management Office will place a due date on the appropriate line (EO or ECA).

21) Signatures. The signatures of the cognizant unit engineer and work package manager (responsible engineer) will be obtained during the ECR review cycle. The signature of the CECB Chairman in the Project Office space is both necessary and sufficient to formally accept an ECR for subsequent Engineering Action (i.e., preparation of engineering orders, specification change notices, etc.).

6.1.4 Review and Coordination of ECR's

The review and coordination cycle of an ECR is shown in Figure 6-3.

6.2 ENGINEERING CHANGE ANALYSIS (ECA)

6.2.1 Purpose

This procedure establishes a standard method and procedure for documenting the engineering analysis of approved engineering change requests to permit effective technical, cost, schedule, and contractual evaluation before implementation.

The engineering change analysis (see Figure 6-4 documents the technical requirements, cost, and schedule for accomplishing the change from an engineering point of view and are not to be considered as authority for proceeding with the change beyond the analysis stage.

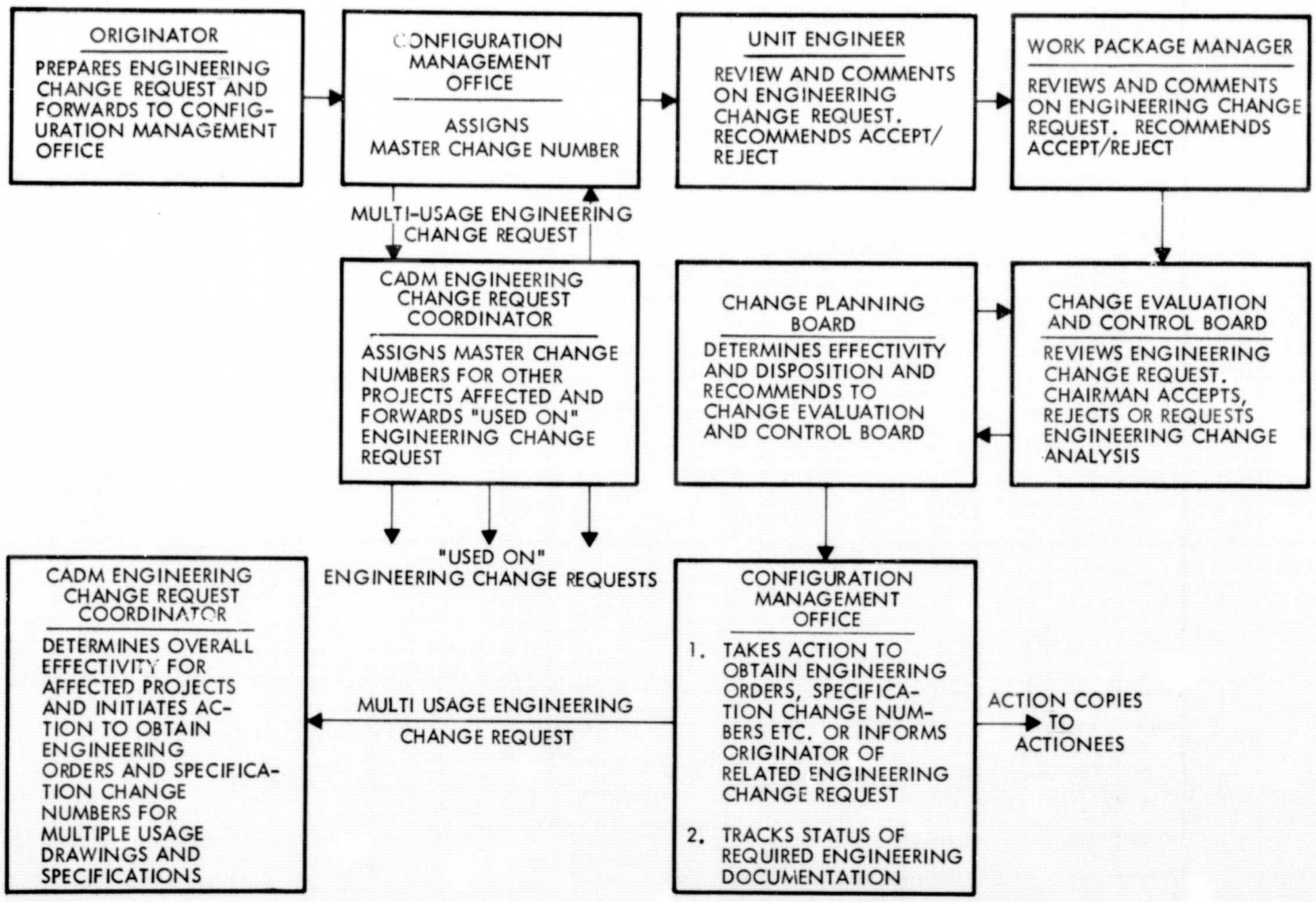

Figure 6-3

ENGINEERING CHANGE REQUEST AND REVIEW FLOW DIAGRAM

DATE

REVISION

SHEET OF

ECA NO.

PROGRAM	PROGRAM SEQ. NO.	CONFIGURED ITEM	CHANGE SEQ. NO.
	CONFIGURED ITEM ECA NO.		
	MASTER ECA NO		

TRW SYSTEMS TRW INC

CODE IDENT. NO. 11982

ITEM AFFECTED

PART NO.

PART NAME

NEXT ASSEMBLY PART NO.

CONFIGURED ITEM

PART NO.

PART NAME

TITLE OF CHANGE

CLASSIFICATION

☐ CLASS I

☐ CLASS II

PRIORITY

☐ COMPATIBILITY ☐ URGENT

☐ IMMEDIATE ☐ ROUTINE

DESCRIPTION OF CHANGE

PARTS AFFECTED

PART NO.	PART NAME	QTY.	DISPOSITION

EFFECTIVITY (CONFIGURED ITEM)

☐ PRODUCTION ☐ REWORK ☐ RETROFIT

PROPOSED PROD. AND REWORK EFF.

FROM _____ TO _____

FROM _____ TO _____

FROM _____ TO _____

PROPOSED RETROFIT EFF.

FROM _____ TO _____

FROM _____ TO _____

FROM _____ TO _____

ITEMS AFFECTED BY CHANGE

☐ SAFETY ☐ PERFORMANCE ☐ INTERCHANGEABILITY

☐ SPECIFICATIONS ☐ TEST PLANS ☐ WEIGHT & BALANCE

☐ DRAWINGS (SPECIFICALLY IDENTIFY EACH ITEM AFFECTED) ☐ RETEST

ENGINEERING DATA RELEASE

(WORKDAYS FROM GO-AHEAD)

DRAWINGS & EO'S _____

SPEC. REVISIONS _____

TEST PLANS & PROC _____

CIA INFORMATION

DATE RECEIVED _____

COMPLETE ACTION BY _____

RELATED ECA'S

ENGINEERING MANHOUR ESTIMATE

MTS	_____	MH _____	$
D&D	_____	MH _____	$
E&L	_____	MH _____	$
C&S	_____	MH _____	$
ODC			$
TOTAL $	_____		

DISPOSITION: ☐ AFFECTED ☐ NOT AFFECTED

UNIT ENGINEER	CCC	DATE
RESPONSIBLE ENGINEER	CCC	DATE

CHANGE APPROVAL

PROJECT OFFICE	CCC	DATE

SYSTEMS 781 REV. 2-66

Figure 6-4

ENGINEERING CHANGE ANALYSIS FORM

6.2.2 Procedure

1) The ERTS Configuration Management Office will prepare ECA's on receipt of approved ECR's requiring such action. The office will:

   a) Identify each ECA with the same number assigned to the ECR initiating the change. The number so assigned to the ECR established the master ECA number for the change.

   b) Reproduce each ECA as required for distribution to the cognizant work package managers.

   c) Assign a "dash number" to each copy of the ECA identifying the cognizant Work Package Manager to whom the ECA is being forwarded.

   d) Attach a copy of the approved ECR to each copy of the ECA and forward to the cognizant work package manager.

2) On receipt of the ECA, with a copy of the approved ECR attached, the cognizant work package manager will indicate effect on his subsystem. When not affected, he will so endorse the ECA and forward to the Configuration Management Office. When affected he will:

   a) Provide the information required by the ECA in the detail necessary to ensure effective evaluation on the part of all affected organizations.

   b) Coordinate change requirements with other affected work package managers as required.

   c) Obtain an ECA identification number from the CMO that correlates his portion of the change to that initiated by the ECR, and uniquely identifies the change to the configured item under his jurisdiction. If the requested change affects more than one configured item, he will list the configured items affected on the ECA form received from the Configuration Management Office and prepare separate ECA's for each configured item affected, and obtain an ECA and dash number identification for each ECA prepared.

   d) Attach whatever data or documents, i.e., layouts, marked-up prints, that would be required to facilitate and expedite evaluation of each ECA.

   e) Forward completed ECA's with attachments to the Configuration Management Office.

3) The Configuration Management Office will review each ECA and:

   a) Log and verify the ECA identification number.

   b) Ensure receipt of ECA's from all cognizant work package managers.

   c) Package and reproduce all related ECA's and accompanying data and forward to the Pioneer F and G CECB Chairman and CECB members.

4) The CECB chairman will review the ECA package and either:

   a) Approve the ECA for direct engineering order release

   b) Gather planning and schedule data and authorize the change by means of an Engineering Change Directive

   c) Convene the CECB as deemed necessary by the urgency of the change.

   In cases a) and b) above, the CECB chairman will pre-coordinate the ECR/ECA package with the responsible manufacturing and quality assurance work package managers prior to approval of the changes.

5) If a CECB meeting is required, each CECB member will review each ECA package upon receipt and be in a position to:

   a) Submit documented analysis and the incorporation plan for each change as it pertains to his function.

   b) Identify problem areas and resolve with affected agency before the scheduled CECB meeting.

   c) Endorse the engineering change directive issued by the CECB chairman reflecting the approval or disapproval status of each change.

6) The CECB chairman's approval or disapproval of ECA's shall be documented by means of the engineering change directive and forwarded to the Configuration Management Office for distribution.

   a) Approved ECA's not requiring NASA approval prior to implementation will be designated as engineering changes subsequent to CECB approval action and will be so designated on the engineering change directive.

b) Approved ECA's requiring NASA/GSFC approval prior to implementation will be designated as engineering change proposals subsequent to the CECB chairman's approval and will be so designated on the engineering change directive. Engineering change proposals will be redesignated as engineering changes subsequent to receipt of NASA/GSFC authorization.

7) Cognizant work package managers will initiate action to implement the requirements specified by each ECA in accordance with the CECB chairman's approval instructions contained within appropriate ECR directive.

6.2.3 Instructions for Preparation of Engineering Change Analysis Form 781

The following instructions shall be used in the preparation of the Engineering Change Analysis Form 781.

1) Date. Date of original analysis or revised analysis date.

2) Revision. All changes to ECA's after original processing by the Configuration Management Office shall carry a revision letter assigned by the Configuration Management Office.

3) ECA No. The Configuration Management Office or cognizant work package manager will identify in accordance with instruction in Procedure 6.2, paragraph 2.

4) Item Affected and Configured Item. The cognizant work package manager will identify.

5) Title of Change. The Configuration Management Office will identify change title at time of release of original ECA's to the cognizant work package manager when additional ECA's are required.

6) Classification and Priority. Classification and priority will be identical to that shown on approved ECR's.

7) Description of Change. The cognizant work package manager will clearly describe engineering changes required. If additional space is required use engineering change supplement (Figure 6-2).

8) Parts Affected. The cognizant work package manager will list all parts affected by the change and their recommended disposition.

9) Effectivity. The cognizant work package manager will check the appropriate block and recommended effectivity. "Production" indicates hardware in fabrication. "Rework" indicates hardware in stores or integration area. "Retrofit" indicates hardware accepted by NASA/GSFC.

10) Items Affected by Change. The cognizant work package manager will check appropriate blocks and shall describe effects on a supplement sheet (Form 782).

11) Engineering Data Release. The cognizant work package manager will indicate the number of workdays to complete engineering data release.

12) Configuration Management Office Information. Configuration Management Office will complete.

13) Engineering Man-Hour Estimate. The cognizant work package manager will list man-hours required to complete change.

14) Disposition. The cognizant work package manager will check the appropriate block.

15) Signature. As authorized.

6.3 ENGINEERING CHANGE DIRECTIVE (ECD)

6.3.1 Purpose

This procedure establishes the method and procedure for documenting and formally communicating to all company functions the (1) approval/diapproval status of engineering changes to the ERTS Project submitted to the CECB (and other ECA changes as deemed necessary by the ERTS Project Office), and (2) implementation plan and schedule for each such change approved.

6.3.2 Policy

- The chairman of the CECB will document all decisions and the implementation plan pertinent to each engineering change by means of an engineering change directive (Figure 6-5).

- An ECD shall be prepared and issued for all changes submitted to the CECB chairman for decision through the engineering change analysis procedure. An ECD will be issued in all cases to reflect the disapproval as well as the approval of proposed changes.

	DATE	ECD NO.	PROGRAM	PROGRAM SEQ. NO.	CONFIGURED ITEM	CHANGE SEQ. NO.
	REVISION		CONFIGURED ITEM ECD NO.			
TRW SPACE TECHNOLOGY LABORATORIES THOMPSON RAMO WOOLDRIDGE INC ONE SPACE PARK — REDONDO BEACH, CALIFORNIA	CODE IDENT. NO. 11982	SHEET OF	MASTER ECD NO.			

TITLE OF CHANGE	CONFIGURED ITEM	PART NO. _____ PART NAME. _____

CONFIGURED ITEM EFFECTIVITY			CLASSIFICATION	PRIORITY	
PRODUCTION: SER. NO. THRU SER. NO.	REWORK SER. NO. THRU SER. NO.	RETROFIT SER. NO. THRU SER. NO.	☐ CLASS I ☐ CLASS II	☐ COMPATIBILITY ☐ URGENT ☐ IMMEDIATE ☐ ROUTINE	

COMMITMENTS

FUNCTION ENDORSEMENT	REMARKS:	ACTION	PRODUCTION (DATE)	SPARES (DATE)

RELATED ECDs	APPROVED:

ENGINEERING DESIGN
- A1 Engineering Drawing Release
- A2 Retrofit Kit Drawing Release
- A3 Advanced Material Release
- A4 Parts Specification Release
- A5 Material Specification Release
- A6 Process Specification Release
- A7 Equipment Specification Release
- A8 Test Specification Release

WORK UNIT MANAGER
- B1 Purchase Request Issue/Revision
- B2 Work Order Issue/Revision

WORK PACKAGE MANAGER
- C1 Work Unit Issue/Revision

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MATERIAL
- D1 Purchase Order Issue/Revision
- D2 Sub-Contract Issue/Revision
- D3 Material/Services Availiable (on Dock)
- D4 Retrofit Kit - Ship
- D5 Spares - Ship

FABRICATION
- E1 Fabrication /Test Complete
- E2 Retrofit Kit Fabrication/Test Complete
- E3 Purchase Request Issue/Revision

INTEGRATION - TEST
- F1 Hardware to Fabrication
- F2 Purchase Request Issue/Revision
- F3 Integration Complete
- F4 Test Complete

PRODUCT SUPPORT
- G1 Spare Parts Release Issue/Revision
- G2 Handbook Revision
- G3 Install Retrofit Kits
- G4 TCTO
- G5 Depot Test Capability
- G6 Retrofit Kit Trial

(* See Attached Engineering Change Supplement)

CONTRACTS
- H1 ECP Number
- H2 ECP Complete
- H3 ECP Coordinated
- H4 STL Proposal No.
- H5 ECP to Customer
- H6 Customer Authorization Required
- H7 Customer Authorization Received
- H8 Sales Work Authorization Number
- H9 GFE Required
- H10 GFE Customer Schedule

PRODUCT ASSURANCE
- J1 Receiving Inspection
- J2 Inspection Procedures Issue/Revision
- J3 Test Equipment Available
- J4 Purchase Request Issue/Revision

FACILITIES
PRICING
SPECIAL COMMITMENTS
CECB CHAIRMAN

Figure 6-5

ENGINEERING CHANGE DIRECTIVE

- The ECD may also be optionally used by the Project Office to approve ECR's and ECA's not submitted to the CECB chairman where the impact of the ECR and/or ECA on planning and scheduling so requires. In this case, the CECB chairman will directly gather the appropriate planning and scheduling data and authorize the change.

- An appropriately endorsed ECD will serve as a directive to all affected TRW functions to implement approved configuration changes in accordance with the planning and scheduling data thereon.

6.3.3 Procedure

1) An ECD (Figure 6-5) will be prepared for each ECA reviewed by the CECB at scheduled meetings to document decisions and the implementation plan established for each change. Specifically the CECB chairman will:

   a) Identify each ECD with the same number that is assigned to the ECA.

   b) Designate approved changes that do not require NASA/GSFC approval as engineering changes (EC) on the directives, referred to hereinafter as EC directives.

   c) Designate approved changes that do require NASA approval as engineering change proposals (ECP) on the directives, referred to hereinafter as ECP directives.

   d) Record CECB decisions, planning, and scheduling commitments by functional area as required by the ECD.

   e) Obtain endorsement of each CECB member for each ECD prepared at scheduled meetings.

2) The CECB will instruct the Configuration Management Office to reproduce and distribute appropriately endorsed ECD's to all functions as required.

3) The CECB chairman will forward completed ECP directives and supporting change analysis documentation submitted by affected functions to Contracts Administration. The Project Configuration Management Office will reproduce and distribute copies of completed ECP directives to CECB members and to such limited distribution as authorized by the F and G Project Office.

4) The Configuration Management Office in conjunction with Contracts Administration will prepare, coordinate, and submit engineering change proposals to NASA/GSFC.

5) In notification by NASA/GSFC that an ECP is either approved or disapproved, Contracts Administration will:

   a) Prepare a sales work authorization for each approved ECP and forward to the CECB chairman and to appropriate distribution.

   b) Forward appropriate notification to the CECB chairman for those ECP's disapproved by NASA/GSFC.

6) At receipt of the SWA, the CECB chairman will review the implementation plan reflected by the appropriate ECP directive in conjunction with the authorization reflected by the sales work authorization and either;

   a) Redesignate the ECP directive as an EC directive when the implementation plan and authorization are synonymous, or

   b) Reconvene the CECB to review the implementation plan when authorization is later than requested, or authorization differs in proposed intent, scope, or implementation. Based on the chairman's decision, the ECP directive may be revised, reissued, and resubmitted through Contracts Administration to NASA/GSFC, or redesignated as an EC directive and issued as authority to implement the change as specified by the directive.

7) Affected functions will initiate action to implement the change in accordance with the planning and scheduling commitments reflected by the ECD.

8) Inability to fulfill the planning or scheduling commitments reflected by the ECD on the part of any function shall be referred to the appropriate CECB member for resolution.

6.3.4 Instructions for Preparation of Engineering Change Directive Form 2043

The following instructions shall be used in the preparation of the Engineering Change Directive Form 2043.

1) Date. Date of original release or revision date.

2) Revision. All changes to ECD's after initial release shall carry a revision letter assigned by the CECB chairman.

3) ECD No. The CECB shall identify in accordance the master change number system.

4) Directive Designation. The CECB shall check the appropriate block.

5) Title of Change. The CECB shall identify with the same title as the related ECA.

6) Configured Item. The CECB shall identify the configured item affected by the ECD.

7) Configured Item Effectivity. The CECB shall show effectivity of the approved change. "Production" indicates hardware in fabrication area. "Rework" indicates hardware in stores or integration area. "Retrofit" indicates hardware accepted by NASA.

8) Classification and Priority. The CECB shall check appropriate blocks.

9) Commitments. Each member of the CECB shall fill out the commitment area of the ECD as follows:

Function Endorsement - List function and signature

Remarks - Any special instructions or action not coded

Action - List code identification of action item(s)

Production (date) - List complete date(s) of action item(s)

Spares (date) - List completion date(s) of action item(s) as required

A line shall be drawn across the ECD form separating each endorsement. If additional space is required, use Engineering Change Supplement Form 782.

10) Related ECD's. The CECB shall list all related ECD's comprising a change package.

11) Approved. The CECB chairman shall sign all ECD's. If change is rejected, he shall so indicate.

6.4 ENGINEERING CHANGE SUMMARY (ECS)

6.4.1 Purpose

This procedure establishes the method and procedure for identifying and listing the complete engineering data required to implement approved engineering changes for the ERTS Project.

6.4.2 Procedure

1) After receipt of an engineering change (EC) directive, the cognizant work package manager will:

   a) Prepare an ECS listing completely the engineering data required for the change by specific issue (EO, SCN, etc.), (Figure 6-6). ECS's reflecting a complete listing of required data shall be marked at "engineering complete".

   b) When required by schedule lead-time or other compelling reason to release partial engineering data, the cognizant work package manager will list all engineering data required for the change by document number. The specific issue (engineering order, specification change notice, etc.), of each document so listed will be entered to the extent known. Those items not identifiable to specific issue due to lead-time considerations will be noted on the ECS as "not released."

   c) Reissue "partial listing" ECS's as necessary through the Configuration Management Office to reflect required engineering data until the "engineering complete" listing is issued.

2) The cognizant work package manager will forward ECS's to the Project Office through the Configuration Management Office for verification and release. Whenever possible the ECS shall accompany the engineering configuration data being released. However, the preparation of an ECS shall not, in any way, preclude release of required engineering.

3) On receipt of an ECS, the Project Office will:

   a) Verify prior or concurrent release of listed data.

   b) Verify that released engineering data complies with the engineering commitment specified by the engineering change analysis and/or engineering change directive.

   c) Clarify and correct conflicts either with the specific CECB representatives or by CECB action.

   d) Forward ECS and accompanying engineering configuration data, when applicable, to CADM for reproduction and distribution.

	DATE	ECS NO.	PROGRAM	PROGRAM SEQ. NO.	CONFIGURED ITEM	CHANGE SEQ. NO.
	REVISION			CONFIGURED ITEM ECS NO.		
TRW SYSTEMS GROUP ONE SPACE PARK · REDONDO BEACH, CALIFORNIA — CODE IDENT. NO. 11982	SHEET OF			MASTER ECS NO.		

TITLE OF CHANGE	CONFIGURED ITEM — PART NO. _____ PART NAME. _____
EFFECTIVITY	☐ PARTIAL LISTING ☐ ENGINEERING COMPLETE REMARKS:

ENGINEERING DATA REQUIRED FOR CHANGE

ITEM	DOCUMENT NUMBER	REV. LTR	TITLE	DATA TYPE						ENGINEERING RELEASE DATE
				DWG	EO	SPEC	SCN	PLAN	OTHER	

CIA INFORMATION	REMARKS	APPROVED BY:
DATE RECEIVED _____ FOLLOW-UP ACTION BY _____ RELATED ECS'S		UNIT ENGINEER _____ C.C.C. _____ DATE RESPONSIBLE ENGINEER _____ C.C.C. _____ DATE PROJECT OFFICER _____ C.C.C. _____ DATE

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Figure 6-6

ENGINEERING CHANGE SUMMARY FORM

6.4.3 Instructions for Preparation of Engineering Change Summary Form 2042

The following instructions shall be used in the preparation of the engineering change summary (ECS) Form 2042.

1) Date. Date of original release or revision date.

2) Revision. All changes to ECS's after processing by the Configuration Management Office will carry a revision letter assigned by that office.

3) Supersedes. Previous release of ECS's will be shown.

4) ECS No. The cognizant work package manager will identify the ECS with the same designations as the related approved ECA and ECD.

5) Title of Change. The cognizant work package manager will identify the ECS with the same title as the related approved ECA and ECD.

6) Configured Item. The cognizant work package manager will identify the ECS with the same configured item as the related approved ECA and ECD.

7) Effectivity. The cognizant work package manager will list effectivity as shown on the approved ECA and ECD.

8) ECS Status. The cognizant work package manager will mark the appropriate block.

9) Engineering Data Required for Change. The cognizant work package manager will list the information as follows:

Document No.	- List document number of each drawing, specification, etc., required for change package.
Rev. Letter	- List specific revision identification engineering order specification change notice, etc.) of items required for change package. For partial ECS's, list revision identification if available.
Title	- List title of document
Data Type	- Check appropriate block indicating type of data:
DWG	- New drawing
EO	- Revised drawing or outstanding EO

Spec	- New specification
SCN	- Revised specification
Plan	- Test plan, etc.
Other	- Any document other than those list above.
Release date	- Release date for documents listed. For partial ECS's list those available and identify remainder as "not released".

If additional space is required, use engineering change supplement sheet.

10) CIA Information. Configuration Management Office will complete.

11) Remarks. As appropriate.

12) Signatures. As authorized.

6.5 SOFTWARE CHANGE REQUEST FORMS

The configuration control forms define a standardized set of data required to process a change or to report problems that often lead to changes. This section describes the purpose of each form proposed for ERTS configuration control.

The configuration control reports provide an organized approach to changing software while maintaining cognizance of its configuration at all times. These reports are the channels for communicating problems, change requests, and modifications among the software system contractors and cognizant agencies and are used by the software contractor to maintain configuration control of the software program elements and documentation.

6.5.1 Computer Program Engineering Change Proposal

The change proposal provides information on a proposed change that will allow GSFC to evaluate and approve a proposed change to the baseline documentation.

A change proposal is required for all baseline changes and changes that affect schedule or cost; it contains the contractor's estimate of the effect in each area. The proposal furnishes a vehicle for early approval and orderly contractual coverage if extensive modifications are required to the software system.

6.5.2 Software Problem Report

The software problem report is used to report a suspected deficiency in a computer program for which a baseline has been established. The reports are normally written during the formal validation and acceptance phase to document required changes, establish a priority for implementation, and explain the consequences of not making the proposed change. They are normally used to convey information to the software planning board and the CECB for analysis before the change is authorized.

6.5.3 Software Modification Record

The software modification record is a form used to advise the software integrator or GSFC of software (routines) corrector cards which are needed to perform required program modifications. Modifications described in the form have normally been previously justified by software problem reports, and the records explain the detailed coding modification necessary to implement the change. The records are usually written after formal delivery of the software, although they may also document coding changes performed during the formal validation and acceptance.

6.5.4 Data Base Directory Change

Data base directory changes are normally required after the product Stage 2 baseline establishes the contractor-specific data base or computer program internal communication pools. These changes are initiated with a change request written by the contractor. They are implemented by the software integrator at scheduled intervals. The data base directory changes are automatically within the contracted work scope and, unless otherwise stated, do not require GSFC approval.

The form is used to initiate changes to a contractor-specific data base directory or internal communication pool. It is the channel for notifying GSFC that such a change is desired, and aids in planning the data base directory change schedule.

6.5.5 Computer Program Engineering Change Request

The design change request is used to request a change in another contractor's software in support of a change in the requesting contractor's software. The changes involved are typically product improgements that affect a contractor's external interfaces. The form notifies the affected contractor, the software integrator, and GSFC that a change affecting an interface will be required. The normal response is a computer program engineering change proposal from the affected contractor.

6.5.6 Discrepancy Report Form

The discrepancy report is used to report software deficiencies which the program does not perform as described in the documentation. The forms are sent to GSFC for further action. They are five-copy printed forms with provisions for processing without generating additional paper work.

6.5.7 Program Change Record

A program change record provides the necessary followup where other programs, documentation, or additional program blocks are affected by a change submitted via software modification records. It provides a record of changes by corrector cards to a given software configuration so that all documentation will be updated at the next configuration delivery. The form has four copies, and is sent to the contractor's configuration control group in the project office. It includes:

- Changes to correct editorial errors in documentation
- Changes to correct coding errors
- Changes to improve the design or coding technique prior to formal acceptance by GSFC.

Minor changes are processed internally by the contractor as a means of configuration control of the software and software documentation.

6.6 CONFIGURATION CONTROL LIBRARY

A configuration control library for software products will be established by the contractor to provide a computer program accounting system and physical storage facilities for controlled master tapes, listings, decks,

MTM correctors, disk file identifiers, working tapes, and any other items necessary to define and control computer program products.

The configuration control library for the software products will maintain configuration controlled versions of the software for formal validation of the requirements. Updates to the computer programs will require the approval and maintenance of several controlled versions of the software products during the formal validation and acceptance testing phases. Each new version will be reviewed and approved in accordance with this configuration management plan prior to establishing a new software configuration. Records of all changes required to the software products will be maintained in the library consistent with the supporting documentation.

6.7 CONFIGURATION ARTICLE LISTS

The configuration control library will also maintain two sets of configured article lists for configuration identification of the ERTS software. The first catalog set will identify the documents and change proposals that constitute the design baseline documentation. The second configured article list will identify the documents and change control forms that describe the configuration of the software products used during formal validation.

The configured article list for the design baseline documentation will identify such information as:

- Document titles (latest version)
- Document numbers for all baseline documents
- Document publication dates
- Approved change proposals which modify baseline requirements.

The configured article list for documents which describe the acceptance testing configuration of the software will include such information as:

- Requirements documents
- Test procedures documents
- Test results documents

- Data definition specifications
- Interface specifications
- Software modification records and change proposals which apply to the configuration.

As updated configurations of the software are generated during the formal acceptance testing phase, corresponding updated configured article lists will be issued to reflect updated documentation.